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DRQAT-V-3-0-0: User's Manual

Manual for Using the Demand Response Quick Assessment Tool in Large Commercial Buildings

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1 Introduction

1.1 Overview

What is DRQAT?

DRQAT (Demand Response Quick Assessment Tool) is a tool for simulating large commercial buildings developed by LBNL. Up to November, 2009, DRQAT version was 3.0.0 and EnergyPlus version applied into DRQAT was 4.0.0. Large commercial buildings differ from small commercial building in terms of building materials and size, equipment, and utility rates. This tool is based on EnergyPlus simulations of prototypical buildings and HVAC equipment. It incorporates prototypical buildings and equipment and allows the user to specify a relatively small number of important parameters in order to determine a quick assessment of demand response for building thermal mass strategies.

The opportunities for demand reduction and cost saving with building demand responsive controls vary tremendously with building type and location. This assessment tool will predict the energy and peak electrical demand savings, the economic savings, and the thermal comfort impact for various demand responsive strategies.

About This Manual

This manual introduces the program's basic features and also presents the modeling procedure step by step. It covers the most important variable parameters chosen from the latest EnergyPlus version. These parameters are indispensable for predicting the effect of various demand response strategies. To generate baseline energy use for a building, the user enters general building information, utility rate specifics, and baseline building operating and occupancy conditions. By entering a demand response strategy (or strategies), the user can generate energy and demand savings provided by those strategies as compared to the baseline energy use.

Firstly we introduce the basic configuration for installing DRQAT. This is followed by the given example for developing a model by using this tool step by step. For this section of manual, users get to know the features of this program, input parameters and description about output results.

Other Documentation

There are other two correlative documentations about this tool: Engineering Manual and Tutorial for developing and calibrating the building model by using DRQAT.

Engineers Manual

This manual is developed for engineers, program developers and also advanced users. It introduces the engineering and mathematical basis of program calculations in DRQAT. It also presents all of the definitions of input and output parameters, together with explanations of these input and output files. Then this manual provides the method to develop the interface of this program by using Delphi. Finally, it presents the prototypical building models used in DRQAT.

Tutorial to develop and calibrate the model using DRQAT

This tutorial describes three examples to develop and calibrate building models. In order to predict the effect of different demand response strategies applied into these real buildings, it is necessary to calibrate these building models by comparing actual measured data to simulated results.

DRQAT Website

The Beta version of this tool is available for download and public comments. Update information, future releases, and program information about DRQAT can be found on the World Wide Web at URL: http://drrc.lbl.gov/tools-guides.html. To obtain the latest version of the DRQAT, check the web site for the current downloadable version.

2 Installation

2.1 Hardware Requirements

First, make sure your computer system meets these specifications:

- At least 16 MB of random access memory (RAM), configured as extended memory. 32 MB of RAM is preferred for optimum operation.
- Microsoft Windows 2000™, Windows XP™, Windows Vista and Windows 7.
- Hard disk drive with at least 200 megabytes of available disk space.

2.2 Setup

The installation program can be downloaded from the DRQAT web site at:
http://drrc.lbl.gov/tools-guides.html
Follow these steps to install the program:

2.2.1 Installing DRQAT-V-3-0-03-0-0

Run the Setup program (DRQAT-V-3-0-03-0-0.exe). The Setup program will guide you through a series of dialog boxes with simple options. You will be asked to choose the directory path for the location of the installation file on your computer. It is recommended that the software be installed in the default path. The path cannot contain any blank spaces.

2.3 Running DRQAT-V-3-0-0

To run DRQAT-V-3-0-0, click on the Windows 2000™, Windows XP™ or Windows Vista **Start** button, go to the **Program** menu, single click on the DRQAT group, and single click on the DRQAT-V-3-0-0 icon.

2.4 Uninstalling DRQAT-V-3-0-0

To uninstall DRQAT, double click the "unins000.exe" program that can be found in the DRQAT folder or click the windows start menu, click the DRQAT menu, and click Uninstall DRQAT button. Be aware when updating to a newer version of DRQAT that any project information not backed up will be lost when earlier version is uninstalled. Users can move projects saved in the default folder to other folders.

3 Getting Started

3.1 DRQAT Windows

3.1.1 Main window

The main window, as shown in Figure 3-1, is displayed upon startup of DRQAT As with other MS Windows programs, it consists of a series of pull-down menus, several buttons.

Buttons and menu items specific to each DRQAT window are discussed in detail in their respective sections of this manual.

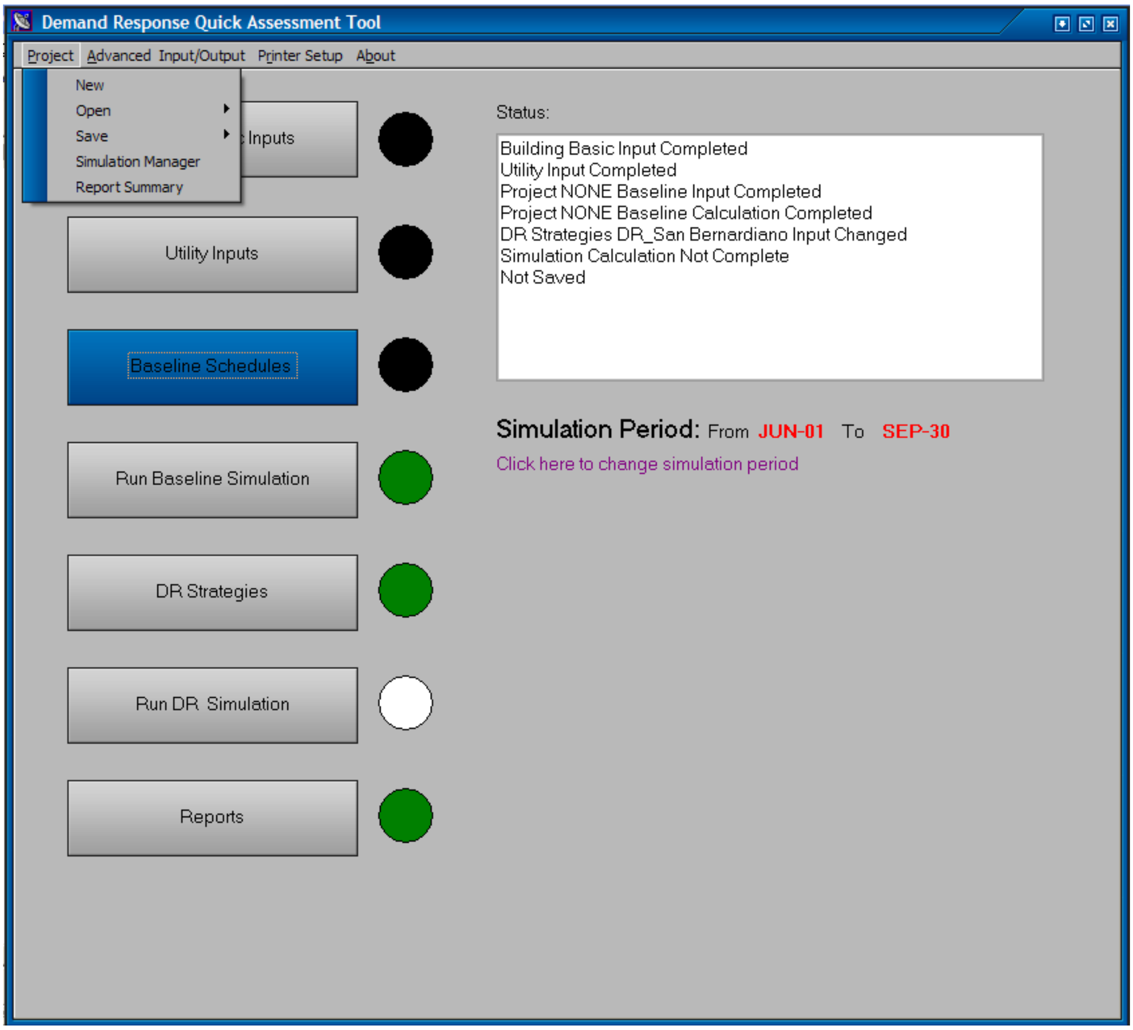


Figure 3-1 Main window of the DRQAT program

There are several buttons on the left of the main window and several pull-down menus on the top of the main window.

3.1.2 Pull-down menus

3.1.2.1 Project

The Project is the pull-down menu in the Main Window where the user will create, open and save the simulation model (projects). Also there is a simulation manager in this menu that is described below.

The "New" button is used to create a new project, as shown in Figure 3-1. To open a saved simulation, click the "open" button. Two sub buttons, "Default path" and "Other path", will be displayed. Choose the desired path. Clicking the "Default path" displays the Simulation Manager window shown in Figure 3-2.

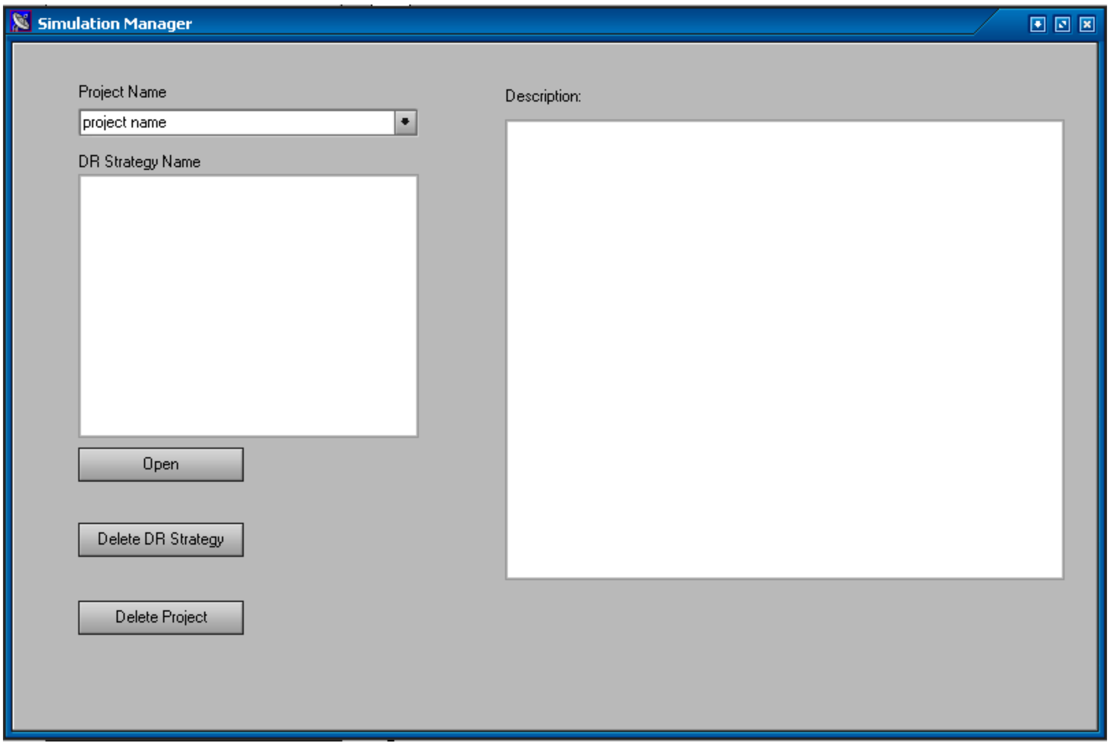


Figure 3-2 Simulation Manager

Choose one project from the projects list. Choose one DR form the DR list box. To open this project, click the "Open" button. To delete a DR strategy, select one from the list of strategies, and click the "Delete DR Strategy" button. To delete a project, select one from the pull-down list of projects, and click the "Delete Project" button.

Attention: all the projects listed in this window are only those projects which have been saved to the default path.

Selecting "Other Path" from the "Open" selection of the "Project" pull-down displays the window shown in Figure 3-3.

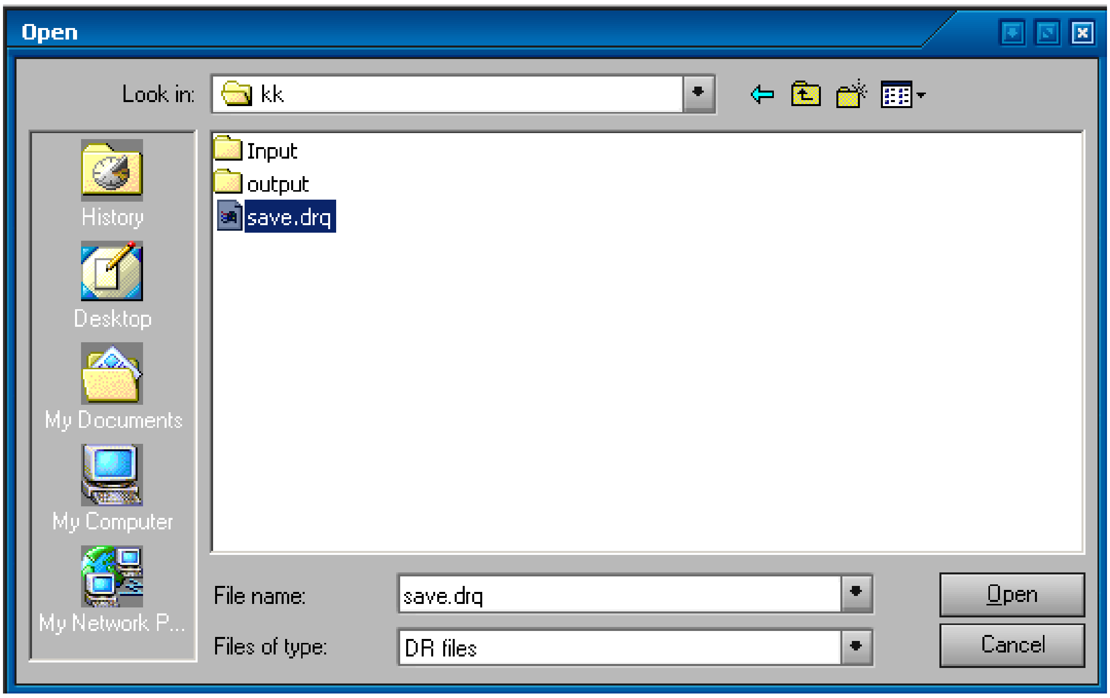


Figure 3-3 Standard open file dialog window

To open a project, change to the path where the project was saved, select the file named "Save.drq", and then click "Open".

The "Save" option in the "Project" pull-down menu is used to save a project. It also contains two sub-options, "Default Path" and "Open Path".

To open or delete more than one project, use the "Simulation Manager" which can be selected in the "Projects" pull-down menu. Functions of the "Simulation Manager" are described above.

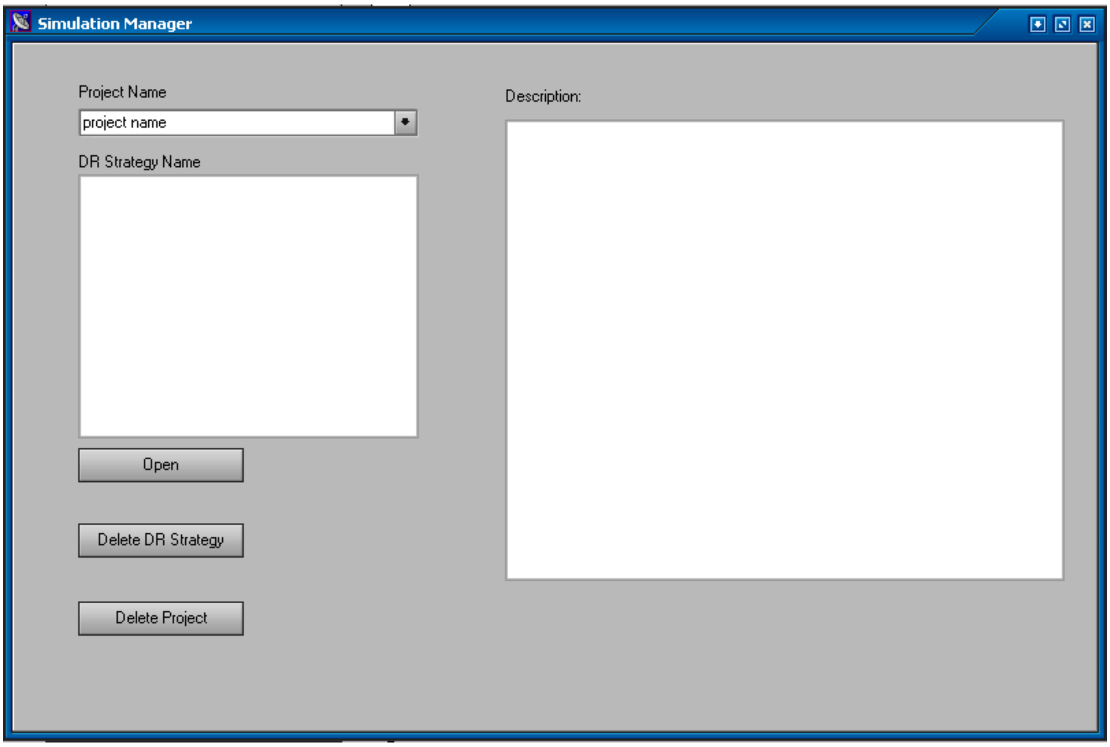


Figure 3-4 Simulation Manager Window

As shown in Figure 3-5, when clicking "Report" after users select reports what they want, these input/output CSV files would be shown to the users and be saved in folders where user want to save. The reports on input of building model are "Building basic information", "Utility" and "Schedules". The reports about output simulation results of the building model include CPP day details, monthly & seasonal energy consumption and energy cost. The content direction of these CSV report files could be horizontal or vertical.

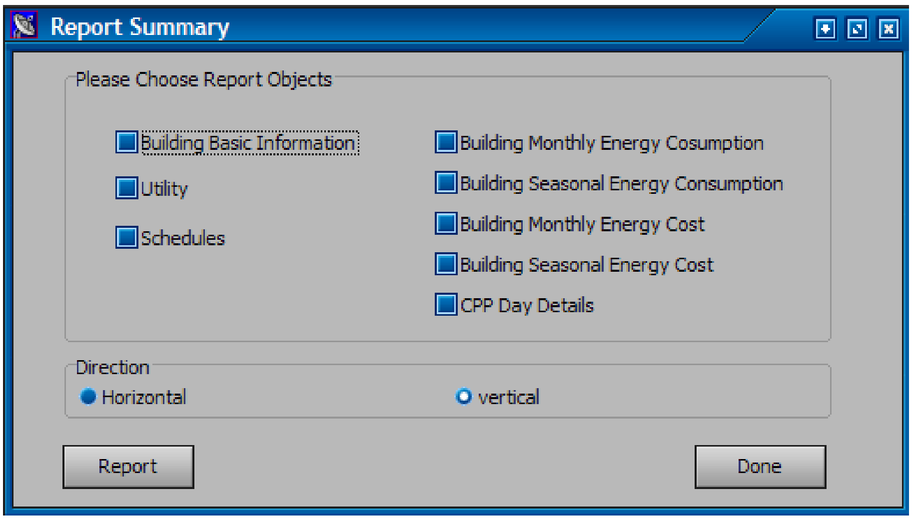
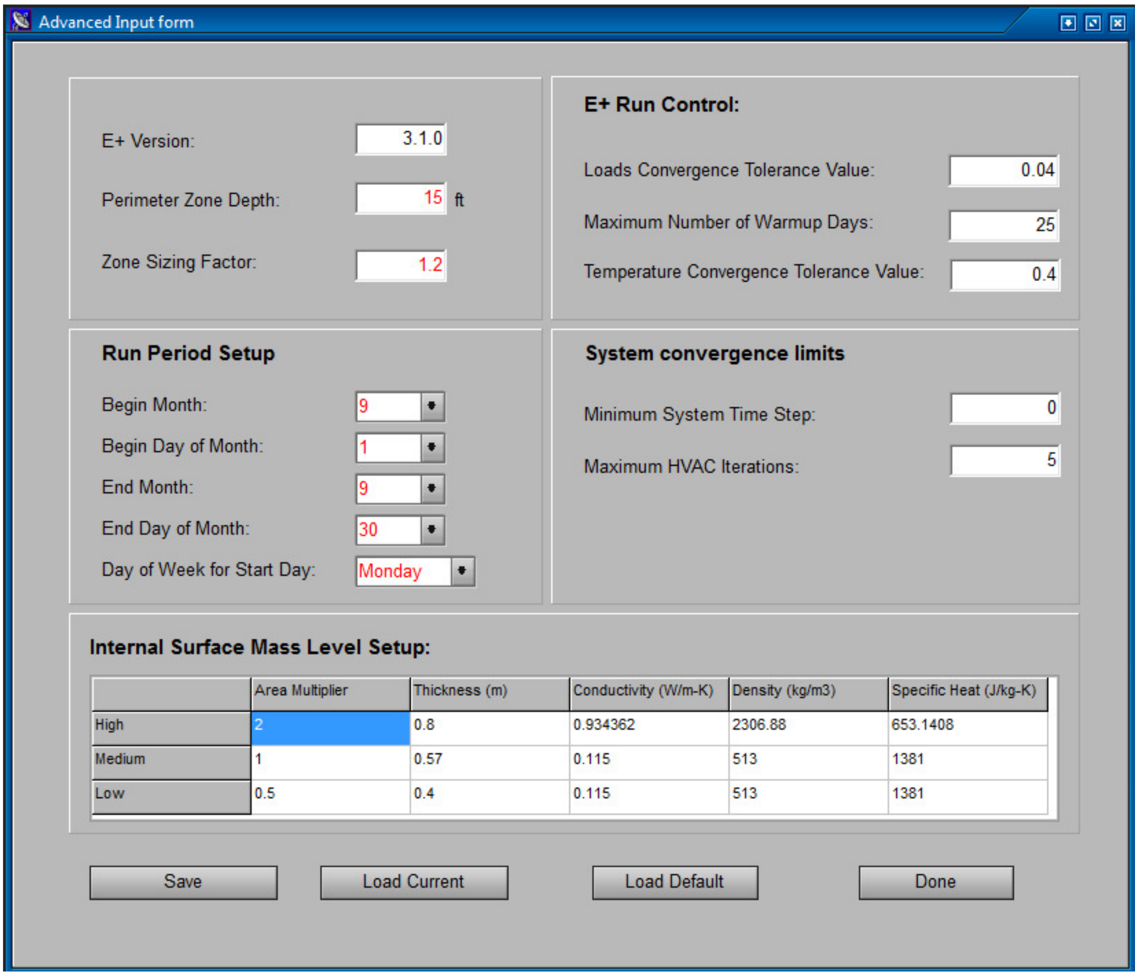


Figure 3-5 report summary Window

3.1.2.2 Advanced Input/Output

The Advanced Input/Output pull-down menu contains two sub buttons: “Advanced Input” and “Advanced Output”. The “Advanced Input” button is used to enter the parameters necessary for running the EnergyPlus software. The “Advanced Output” button is used to show the input and output files of the EnergyPlus simulation, information about CPP days and current climate zone information.

When clicking the **Advanced Input** button you will see the window in Figure 3-6. The Advanced Input window contains the basic information about EnergyPlus parameters.



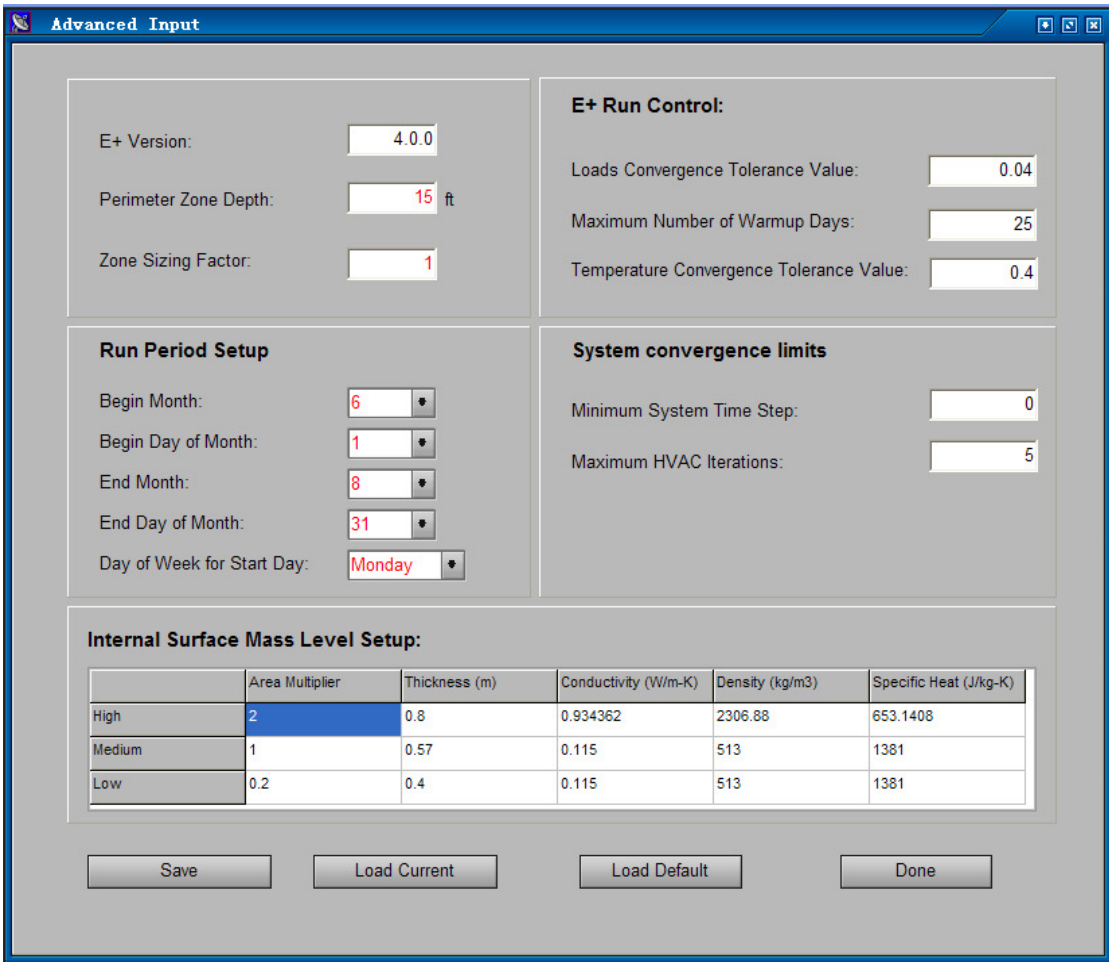


Figure 3-6 Advanced Input Window

3.1.2.2.1 Basic Information

Field: EnergyPlus Version

The "EnergyPlus Version" refers to the version of EnergyPlus software for DRQAT to run. The current EnergyPlus version is 4.0.0.

There are two different building models for DRQAT: Office and Retail. For the office and retail building models, the version of which are EnergyPlus 4.0.0. Users can not replace or change the Energyplus version used in DRQAT. The research team would update these building models to the latest EnergyPlus version.

Field: Perimeter Zone Depth

The depth of the perimeter zone is defined as the distance from the outside wall to the internal zone, where the internal zone is the area of the building not significantly influenced by outdoor ambient conditions.

Field: Zone Sizing Factor

This input is a zone level sizing ratio. The zone design heating and cooling air flow rates and loads will be multiplied by the number input in this field. This parameter should be adjusted when baseline energy predictions do not agree with expectations or when zone temperatures can not reach set-points.

The Zone Sizing object provides the data needed to perform a zone design air flow calculation for a single zone. This calculation assumes a variable amount of supply air at a fixed temperature and humidity. The information needed consists of the zone inlet supply air conditions: temperature and humidity ratio for heating and cooling. The calculation is done for every design day included in the input. The maximum cooling load and air flow rate and the maximum heating load and air flow are then saved for the system level design calculations and for the component automatic sizing calculations (Input/output reference, EnergyPlus manual).

3.1.2.2.2 EnergyPlus Control

Field: Loads convergence
Loads convergence represents the number within which successive iterations of the calculated loads values must agree to satisfy "convergence". (Unit for this field is Watts.)

Field: Temperature Convergence
Temperature convergence represents the number within which successive iterations of the calculated zone temperatures must agree to satisfy "convergence". (Unit for this field is Centigrade).

Field: Maximum Number of Warm up Days
This field specifies the number of "warm-up" days that may be used in the simulation to attain "convergence". The default number (25) should be sufficient for this task. If convergence is not attained with the default number of warm-up days, increasing the number may help.

Note: we recommend that user input default value for these parameters.

3.1.2.2.3 Run Period Setup

Field: Begin Month
This numeric field specifies the first month (1=January, 2=February, etc.) of the desired run period.

Field: Begin Day of Month
This numeric field specifies the first day of the first month (must be valid for month) of the desired run period.

Field: End Month
This numeric field specifies the last month (1=January, 2=February, etc.) of the desired run period.

Field: End Day of Month
This numeric field specifies the last day of the last month (must be valid for month) of the desired run period.

Field: Day of Week for Start Day
The day of the week indicated in the weather file can be overridden by this field's value. A valid day of the week (Sunday, Monday, Tuesday, Wednesday, Thursday, Friday, and Saturday) must be selected in this field.

The weather data for EnergyPlus is a text-based format derived from the Typical Meteorological Year 2 (TMY) weather format. Real weather data would be better to analyze building energy consumption by comparing actual energy consumption to the simulation results.

Especially when users want to simulate building energy consumption by using real weather data, it is very necessary to input the exact day of week for start day.

3.1.2.2.4 System Convergence Limits

Field: System Convergence Limits
Minimum system time step and maximum HVAC iterations are "advanced" features that should be used with caution. They are included to allow users to "speed up" calculations and decrease overall run time. The user should understand the trade-offs between run time and accuracy before changing the default values.

Field: Minimum System Time Step
Usually the minimum system time step is allowed to vary from the zone time step (as maximum) to a minimum time step of 1 minute during certain system calculations. This might be when the system turns on or off, for example. Entering zero in this field sets the minimum system time step equal to the zone time step. It is recommended that the minimum entered be a divisor of the zone time step.

Field: Maximum HVAC Iterations
The HVAC Manager will iterate to a solution or for a set number of iterations. For these variable parameters on system convergence limits, it is not easy to be understood or changed by beginners. Users could use default values to these fields.

Note: we recommend that user input default value for these parameters.

3.1.2.2.5 Internal Surface Mass Level Setup

Any interior wall, floor or ceiling surface is considered Internal Mass as are office furnishings and industrial equipment. Internal Surface Mass is specified for a building being modeled in DRQAT as low, medium, or high. The values of the parameters in the Internal Surface Mass Level Setup table are typical of commercial and industrial buildings and should not be changed unless specific parameter information is available.

These values are typical of commercial buildings. For those special commercial buildings, users could input custom values corresponding to actual internal surface mass level. The "area multiplier" and other characteristics on internal surface mass are changed whatever users want to set according to the actual condition of the building. User can adjust the area multiplier based on the actual thermal mass lever of the building.

Clicking the "Save" button in the "Advanced Input" window saves the current settings. Clicking "Load Current" sets fields to values last saved. Clicking "Load Default" sets fields to default values. Clicking "Done", close the window.

When selecting the "Advanced Output" the window shown in Figure 3-7 is displayed.

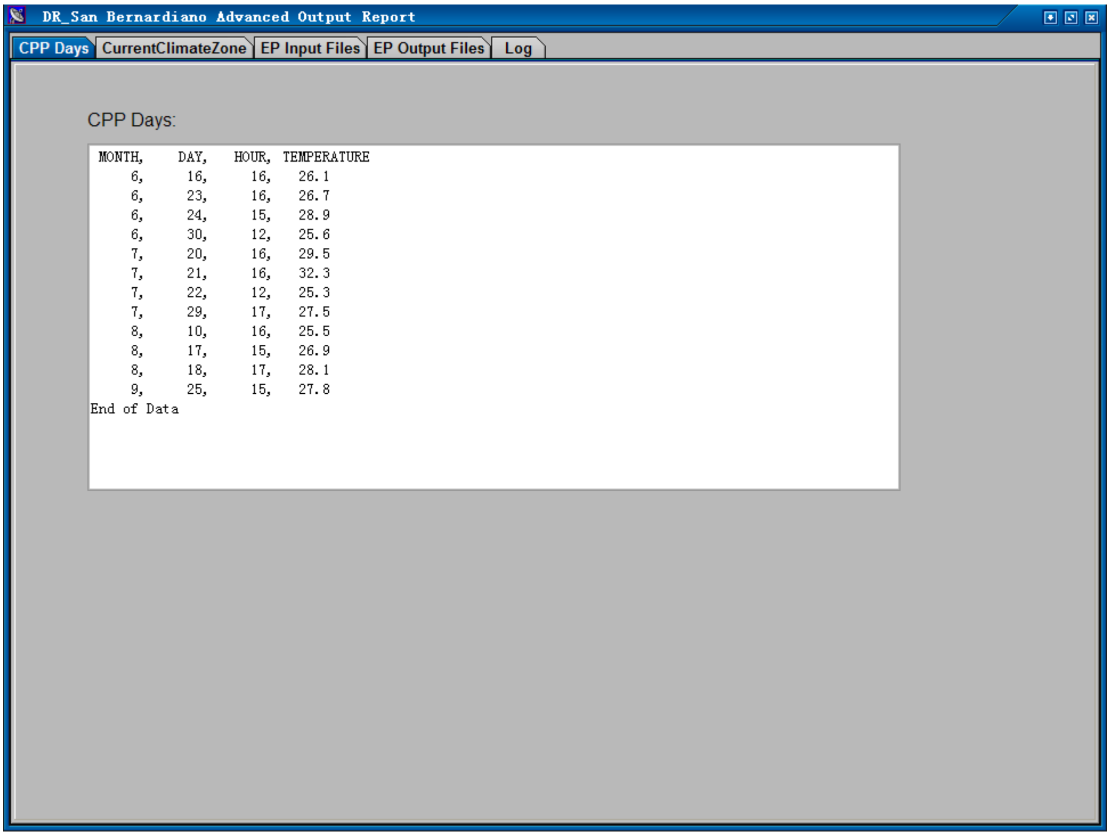


Figure 3-7 Advanced Output window

3.1.2.2.6 CPP Days

CPP is the abbreviation for Critical Peak Pricing, The CPP Days shown in Figure 3-8 are the 12 hottest days in the weather file during the simulation period.

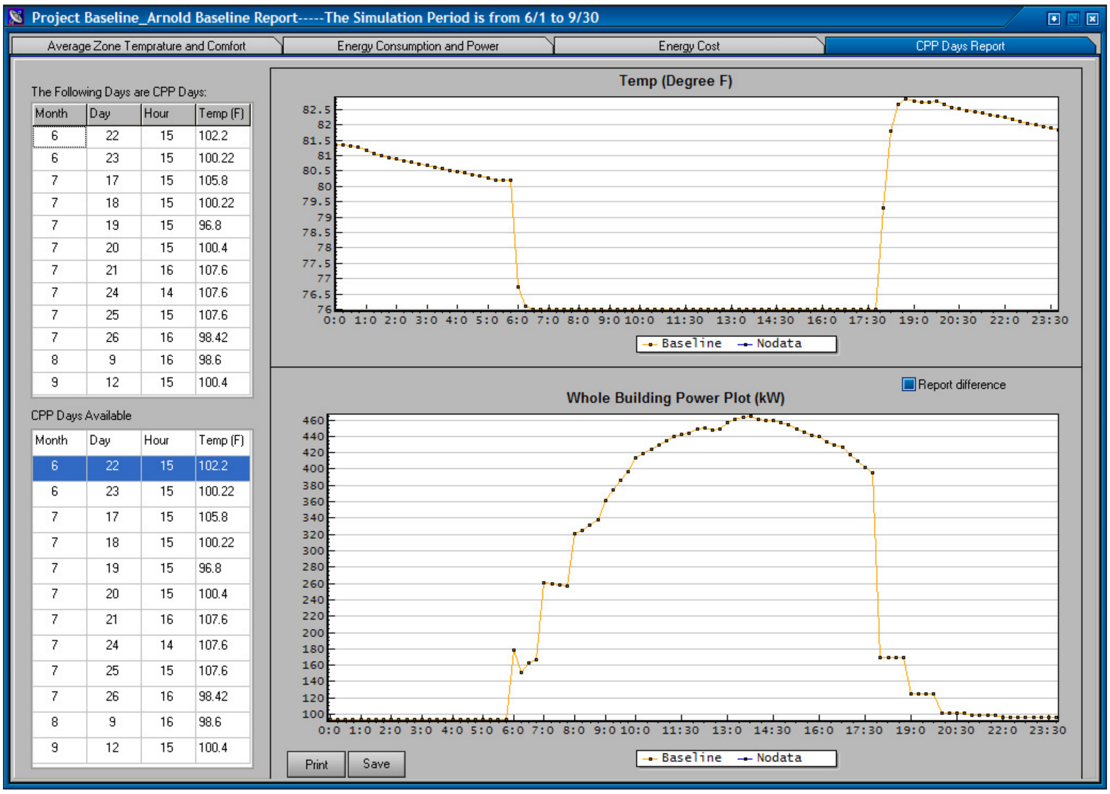


Figure 3-8 CPP days and the simulation results of the whole building power and the zone temperature

3.1.2.2.7 Current Climate Zone

The "Current Climate Zone" tab shows the climate zone that corresponds to the user specified building location. There are 16 climate zones in California.

3.1.2.2.8 EP Input Files

The "EP Input Files" tab shows the "in.idf", "in.imf" and "in.epw" files that DRQAT generates and provides as inputs to the EnergyPlus modeling software. The "in.idf" and "in.imf" input files contain detailed information about the simulation model. "in.epw" is the weather file that corresponds to the climate zone.

3.1.2.2.9 EP Output Files

The "EP Output Files" tab displays the EnergyPlus basic output file and the log file.

3.1.2.2.10 Log

The “Log” tab displays the log of the background batches of the DRQAT software. It would show the AWK files and BAT files which are read and run when simulating the building model.

3.1.2.3 Printer Setup

Clicking “Printer Set-up” in the main pull-downs opens the window shown in Figure 3-9. A4 paper size and Landscape orientation are recommended.

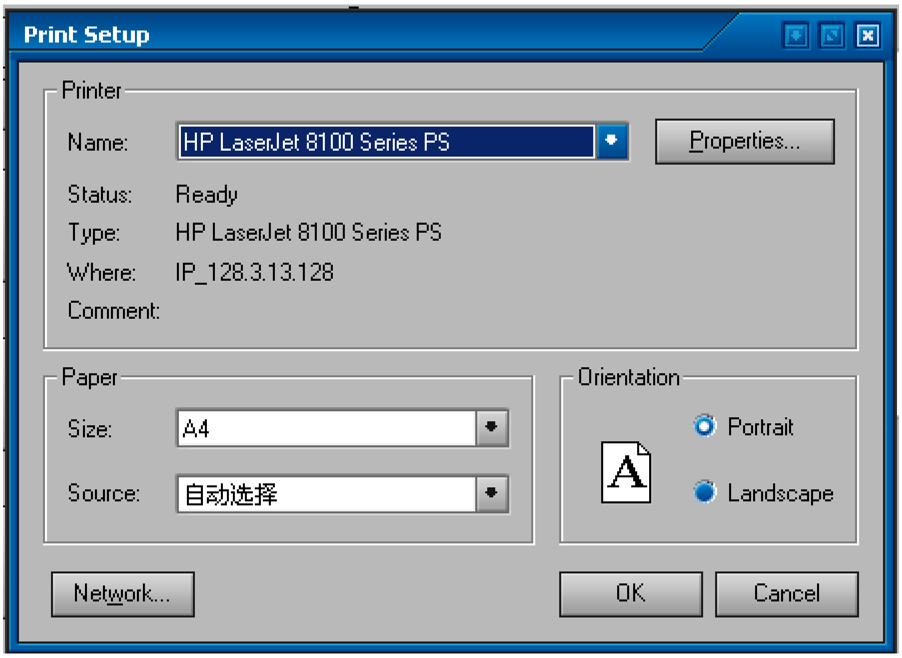


Figure 3-9 Print Set up

3.1.3 Building Basic Input

Clicking the “Building Basic Input” button in the main DRQAT window will display the window shown in Figure 3-10.

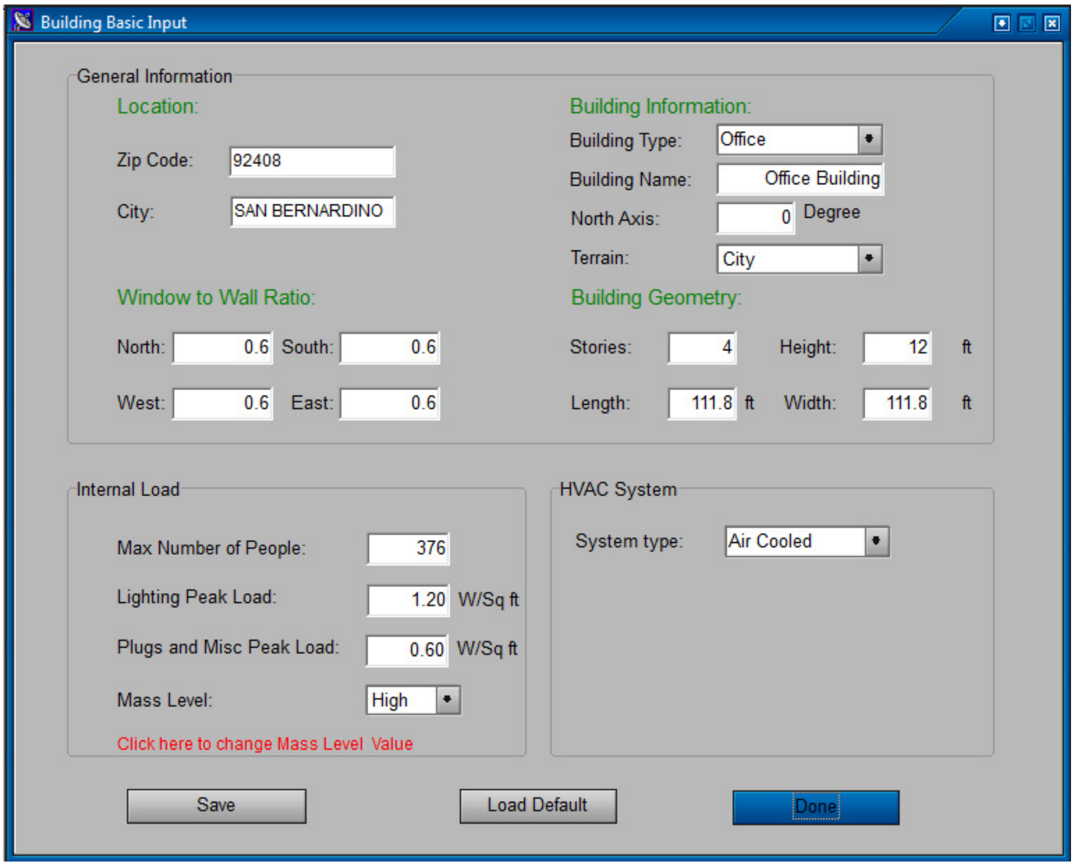


Figure 3-10 Building Basic Input Form

This window is used to input basic building parameters described below. Clicking the "Save" button saves the displayed values. Clicking the "Load Default" button loads default basic building input values. Clicking the "Done" button closes the window.

If the Building Basic Inputs are acceptable a "Saved Successfully" pop-up window will be displayed. Otherwise, an "Error" pop-up window will be displayed and the field with the incorrect value will by highlighted in yellow. Placing the cursor in the field will display the default, minimum, and maximum values for that field.

3.1.3.1 Location

Field: Zip Code
Enter the postal zip code of the building.

Field: City
Enter the name of the city in which the building is located.

3.1.3.2 Building Information

Field: Building Type
Users can select “Office” or “Retail” according to the actual building type. .

Field: Building Name
A name for the building can be entered in this field.

Field: North Axis
Building frequently do not line up with true north. The Building North Axis is specified in degrees from true North (clockwise is positive). The north axis is parallel to building width.

Field: Terrain
The terrain surrounding the building affects how the wind hits the building. Detailed information about this field can be found in the EnergyPlus references.

The site’s terrain affects how the wind hits the building. There are five terrain types: country (Flat, Open country), Suburbs (Rough, Wooded country, Suburbs), city (Towns, city outskirts, center of large cities), ocean (Ocean, Bayou flat country) and urban (Urban, Industrial, Forest).

3.1.3.3 Window to Wall Ratio

For each side of the building (North, South, East, and West) enter the ratio of window surface area to total exterior wall surface area. Different window to wall ratios correspond to different window constructions with the 16 climate zones. Title 24 provides detailed information about window construction standards. Placing the cursor in any of the “Window to Wall Ratio” fields displays the default, minimum, and maximum values for that field.

3.1.3.4 Building Geometry

Placing the cursor in any of the Building Geometry fields displays the default, minimum, and maximum values for that field.

Field: Stories
Enter the number of floors in the building (maximum 50).

Field: Length
Enter length of the building (30 ft to 500 ft).

Field: Width
Enter the width of the building (30 ft to 500 ft).

Field: Height
Enter the height of each story of the building (3 ft to 20 ft).

3.1.3.5 Internal Load

Placing the cursor in any of the Building Geometry fields displays the default, minimum, and maximum values for that field.

Field: Plug and Misc Peak Load
Enter the rated power of the plug load of the building in units of W/Sq ft. An hourly schedule of plug usage can be entered in "Baseline Schedules" as described in section 3.1.5.2.5 (note that plug load is referred to as "equipment").

Field: Lighting Peak Load
Enter the rated power of the lighting load of the building in units of W/Sq ft. An hourly schedule of lighting usage can be entered in "Baseline Schedules" as described in section 3.1.5.2.5.

Field: Max Number of People
Enter the maximum number of building occupants. An hourly schedule of occupancy can be entered in "Baseline Schedules" as described in section 3.1.5.2.5.

Field: Mass Level
This field represents the thermal storage capacity of the internal surfaces of the buildings. There are three qualitative values in this field: "High", "Medium" and "Low". The higher the mass level, the higher energy storage of the internal surfaces of the building could be stored.

3.1.3.6 HVAC System

Field: System type
There are two types of HVAC system for office and retail buildings, the plant of which are water-cooled chiller and direct expansion rooftop unit respectively.

3.1.4 Utility Inputs

The energy cost post-process program calculates energy costs according to tariffs that you specify using Utility Inputs. It defines the most basic features of a tariff: units, uniform energy and demand cost rates, monthly charges. "Utility Inputs" also allows costs to be defined that vary by time based on the time of use rate schedule.

Clicking the "Utility Inputs" button opens the window shown in Figure 3-11. This window allows the user to enter specific utility rate information.

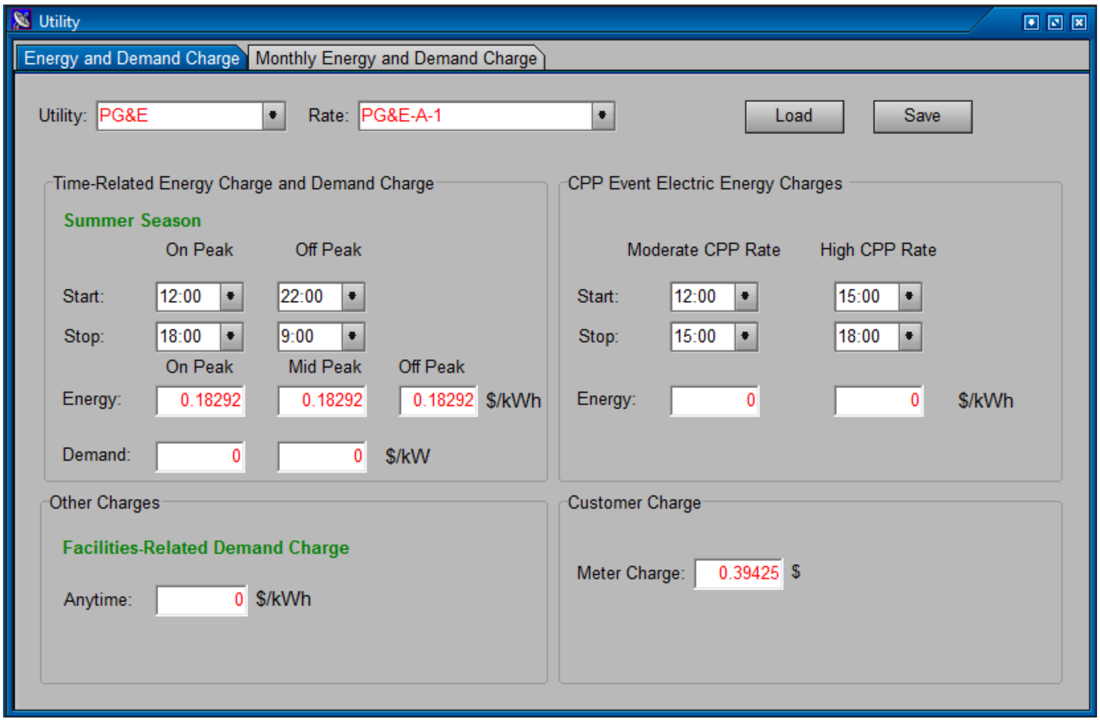


Figure 3-11 Utility Inputs window

The table at the top of the "Utilities Input Form" window defines the hourly energy rates and demand charges. Hour 1 is defined as midnight to 1 AM; hour 2 is 1 AM to 2 AM, etc. The user can create new rates, edit or delete existing rates. A rate can be edited by overwriting the existing value in the desired cell or by choosing a rate from the list box below the table on the far left, selecting the start hour, end hour, and the utility value, followed by clicking the "Enter" button.

Users could input custom charge values based on the utilities used in actual building to override the default utility values. When users click "Check" button, DRQAT would check the monthly schedules whether these utility fields be input by energy and demand charge values or not during simulation period.

The table at the bottom of the window (See Figure 3-11) defines the rate type (e.g. Rate-1, Rate-2, etc.) that applies to each day in the simulation period. The red label below the table shows the simulation period. A rate type must be entered for every day of the simulation period. Rates may be entered by either clicking on the day and selecting the rate in the pull-down menu or by specifying start month, start day, end month, end day, and value (or rate type) in the pull-down menus below the table, followed by clicking "Enter". Clicking the "Default Value" button sets the selected cell to its default value

Clicking the "Find CPP Days" button highlights the CPP (Critical Peak Pricing) days in green in the "Monthly Energy and Demand Charge Schedules" table. Rates for the CPP days should be changed to a rate appropriate for CPP days.

Clicking the "Save" button saves the current entries. Clicking the "Load Default" button loads default values. Clicking the "Done" button closes the window.

3.1.5 Baseline Input

Clicking the "Baseline Schedules" button in the main window displays the window shown in Figure 3-12. Two sub-menus appear in the "Baseline Schedules" window.

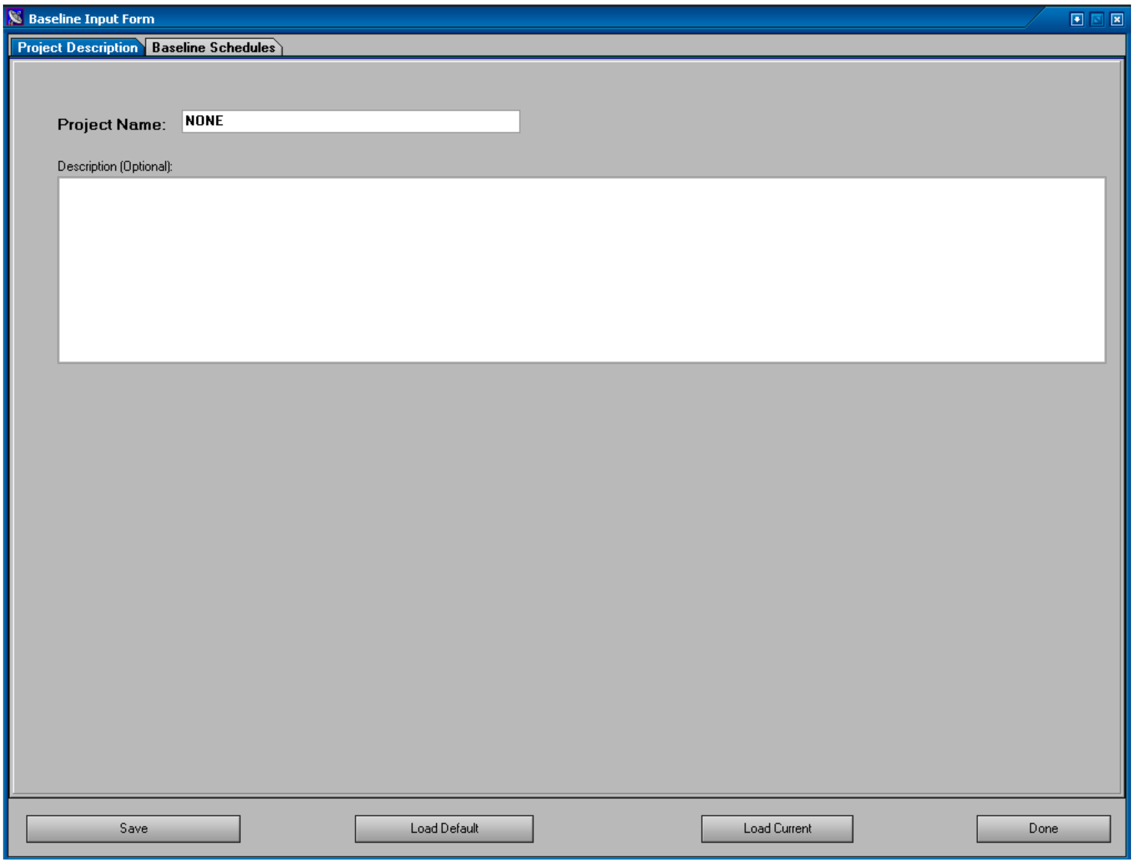


Figure 3-12 Baseline Schedules Input

3.1.5.1 Project Description

The "Project Description" window shows the project name and description entered when the project was created and allows the user to make edits.

3.1.5.2 Baseline Schedules

The "Baseline Schedules" tab consists of five sub-tabs: HVAC Equipment Schedule, Zone Temp Set-point, Chilled Condenser Water Set-point, Supply Air Temp Set-point, and People/Lighting/Equipment Schedule.

DRQAT defines two types of days, workday (Monday-Friday) and holiday (any non-working Monday-Friday and all Saturdays and Sundays.

3.1.5.2.1 HVAC Equipment Schedule

The "HVAC Equipment Schedule" tab (shown in Figure 3-13) allows the user to specify hourly operating schedules for HVAC fans and chillers.

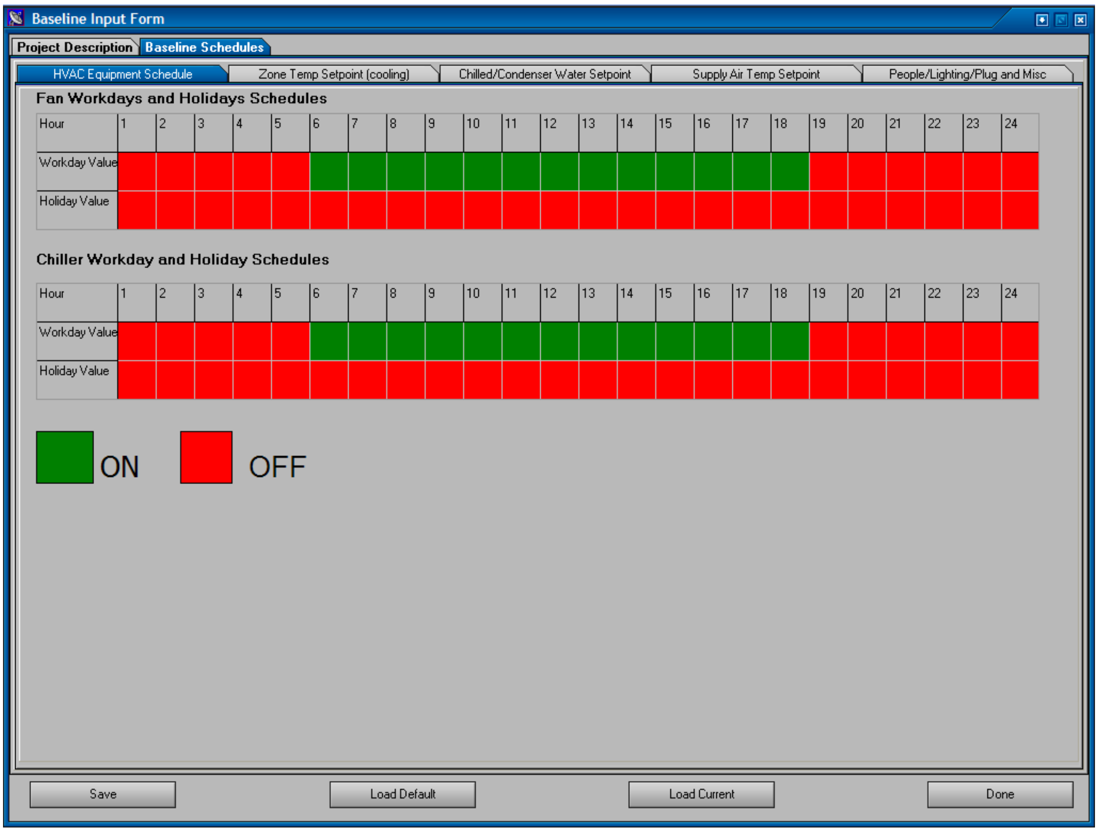


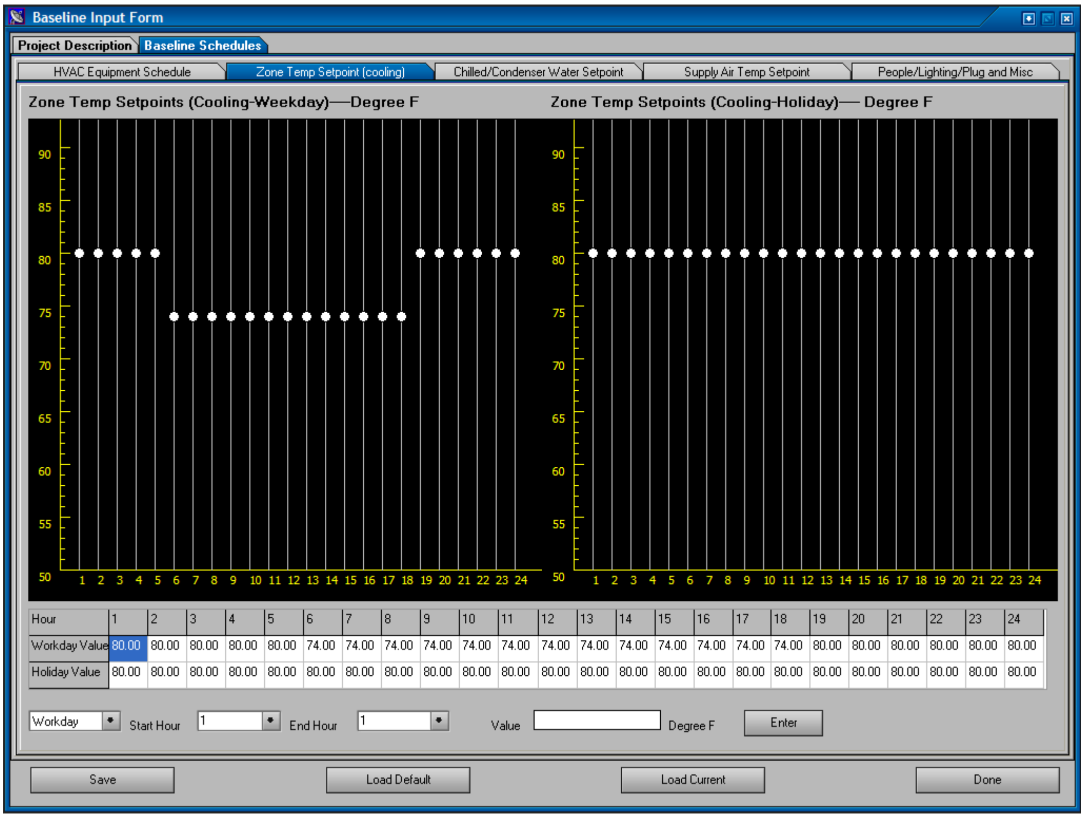
Figure 3-13 HVAC Equipment Schedule

Field: Fan Workdays and Holidays Schedules
Supply fan operating schedule. The color of the square indicates the fan is on (green) or off (red). Clicking on the square changes the value.

Field: Chiller Workdays and Holidays Schedules
Operation schedule of chiller (cooling plant): The color of the square indicates the fan is on (green) or off (red). Clicking on the square changes the value.

3.1.5.2.2 Zone Temp Cooling Set Point

This page allows the user to define the zone temperature cooling set point on workdays (Mon-Fri) and holidays (non-working Mon-Fri and Sat-Sun). See Figure 3-14. Units are ℉. Hour 1 is defined as midnight to 1 AM; hour 2 is 1 AM to 2 AM, etc.



Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Workday Value	80.00	80.00	80.00	80.00	80.00	74.00	74.00	74.00	74.00	74.00	74.00	74.00	74.00	74.00	74.00	74.00	74.00	74.00	80.00	80.00	80.00	80.00	80.00	80.00
Holiday Value	80.00	80.00	80.00	80.00	80.00	80.00	80.00	80.00	80.00	80.00	80.00	80.00	80.00	80.00	80.00	80.00	80.00	80.00	80.00	80.00	80.00	80.00	80.00	80.00

Figure 3-14 Zone Temp Set Point-Cooling

There are three methods to input hourly cooling set point values. The first method is to input the value in the table directly by highlighting and overwriting an existing value. The second method is to use the pull-down selections and value entry text box below the table. Select Workday or Holiday in the first pull-down menu, then choose the start hour and the end hour in the second and third pull-downs, input the cooling set point value for that period, value and click the "Enter" button. The third method is to use the cursor to move the white dots in the graph to the desired cooling set-point at each hour.

Clicking the "Save" button saves the current settings. Clicking "Load Current" sets fields to values last saved. Clicking "Load Default" sets fields to default values. Clicking "Done" closes the window.

3.1.5.2.3 Chilled/Condenser Water Set Point

This page is used to define the hourly schedules of the chilled water temperature and the condenser water temperature set points. See Figure 3-15. Units are ℉. See section 3.1.5.2.3 for a description of how to enter set point values.

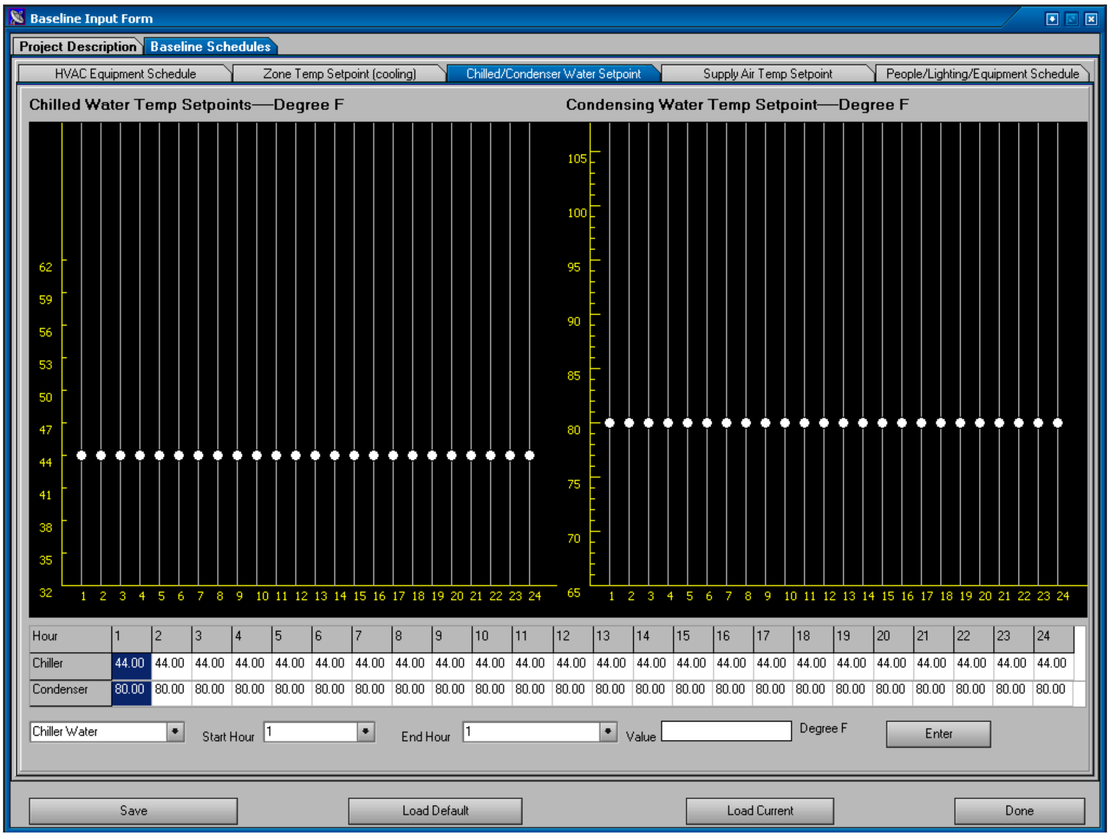


Figure 3-15 Chilled/Condenser water Set-point

3.1.5.2.4 Supply Air Temp Set-Point

This page is used to define the schedules of the supply air temperature. See Figure 3-16. Units are °F. See section 3.1.5.2.3 for a description of how to enter set point values.

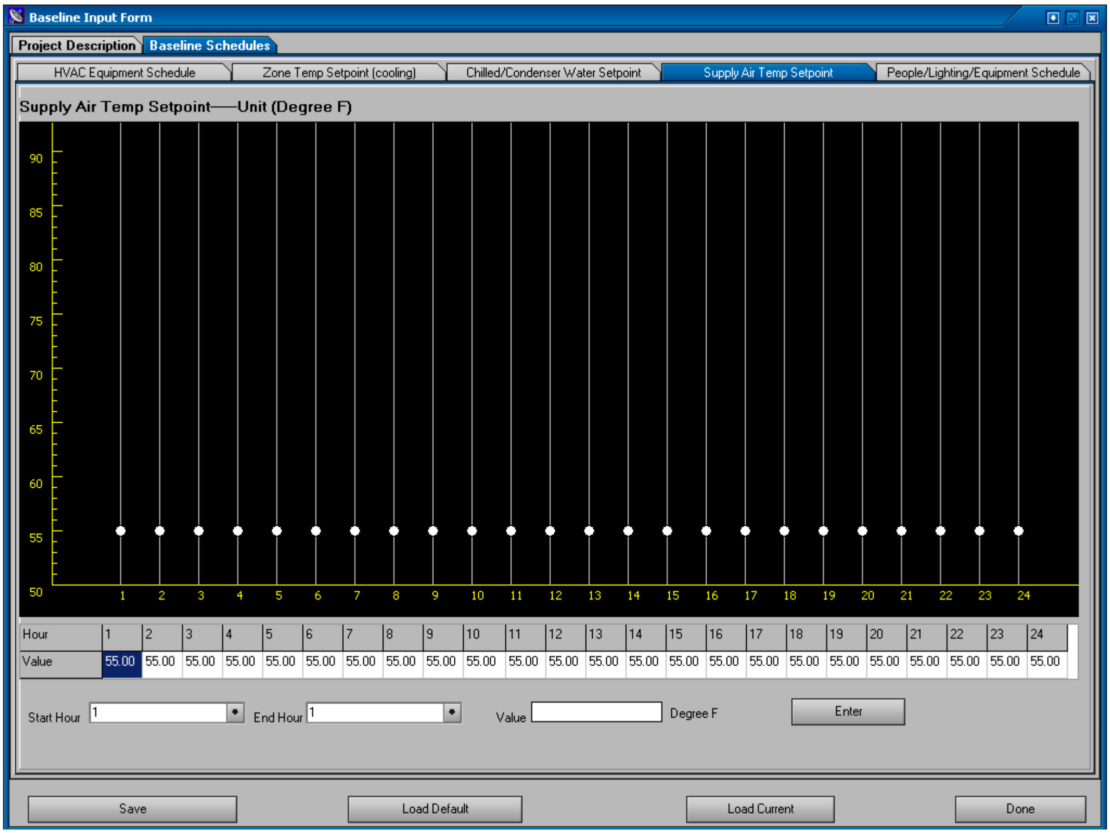


Figure 3-16 Supply Air Temp Set-Point Window

3.1.5.2.5 People/Lighting/Equipment Schedules

This page (shown in Figure 3.17) is used to enter schedules for occupancy, lighting usage, and equipment (or plug-load) usage. For each hour, a percentage of the maximum occupancy, lighting load, or plug load (maximum values are specified in the Building Basic Input Form; see section 3.1.3) is entered. Hour 1 is defined as midnight to 1 AM, hour 2 is 1 AM to 2 AM, etc. Percentages of maximum values are entered by placing the cursor above the desired hour at the desired percent value and clicking.

Clicking the “Save” button saves the current settings. Clicking “Load Current” sets fields to values last saved. Clicking “Load Default” sets fields to default values. Clicking “Done” closes the window.

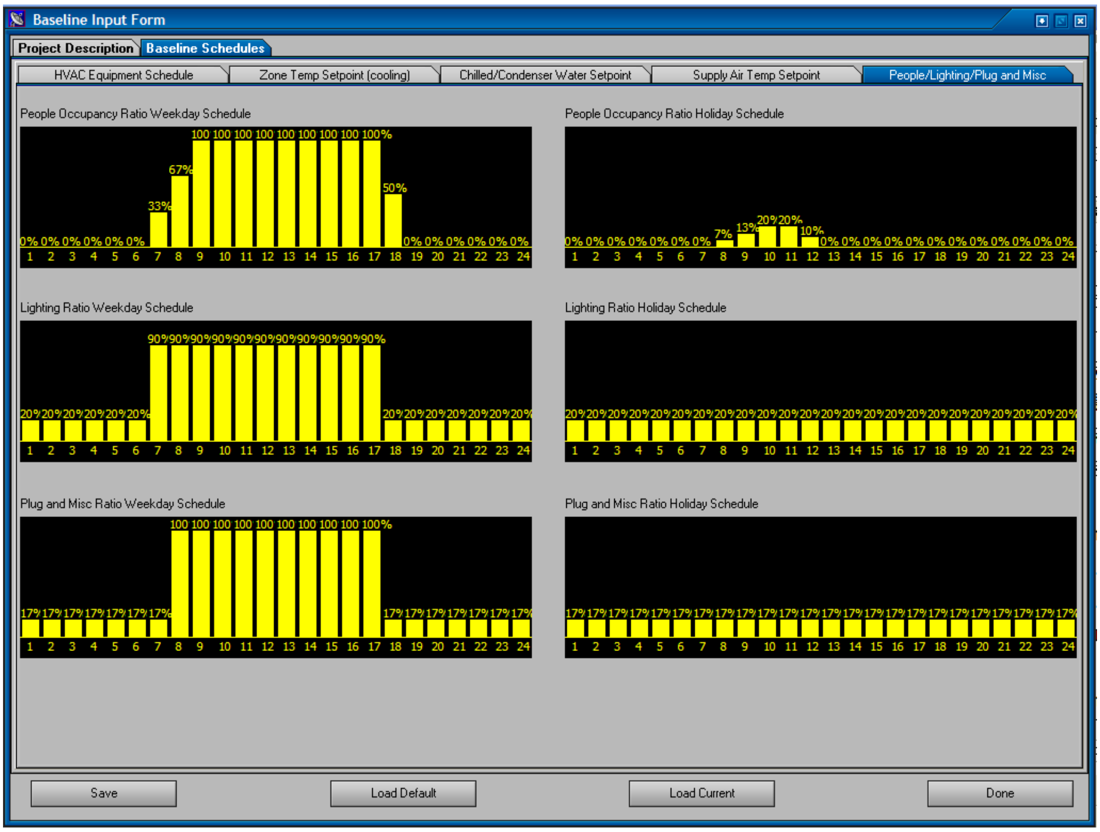


Figure 3-17 People/Lighting/Equipment Schedule

3.1.6 Run Baseline Simulation

Clicking the "Run Baseline Simulation" button in the main window opens the window shown in Figure 3-18 and is used to run the calculation of the baseline energy model predictions for the current project. The calculation can take a few minutes, depending on the computer system.

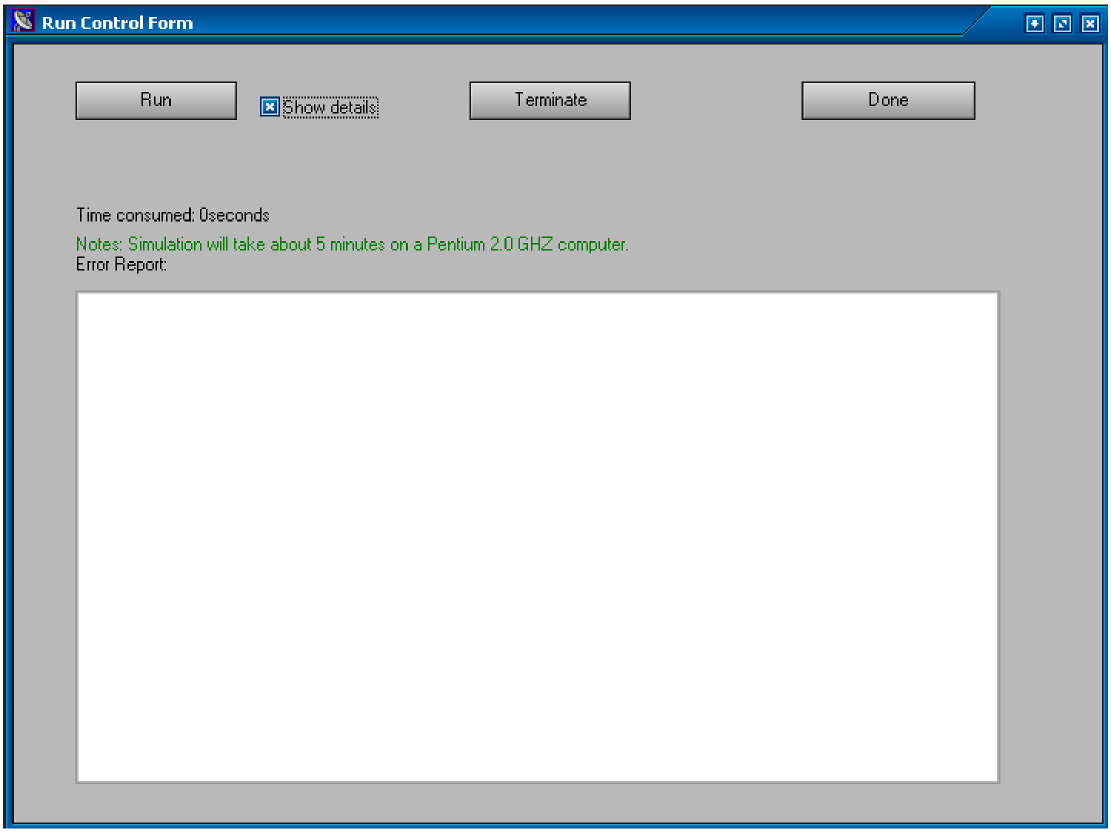


Figure 3-18 Run Baseline Simulation

Button: Run
Clicking the "Run" button starts the run. If the "Show details" button is checked a DOS window will display the DRQAT command and instruction activity. The run can take several minutes. An "OK" pop-up will open at the completion of a successful run. If a run fails to run successfully errors will be listed in the "Error Report" text box.

Button: Terminate
Clicking the "Terminate" button stops the run.

Button: Done
Clicking the "Done" button closes the window. If a run has been successfully completed the "Report" indicator in the main window will have turned from black to green.

3.1.7 DR Strategies

Clicking the DR Strategies button in the DRQAT main window will display the DR Strategies Input Form window shown in Figure 3-19.

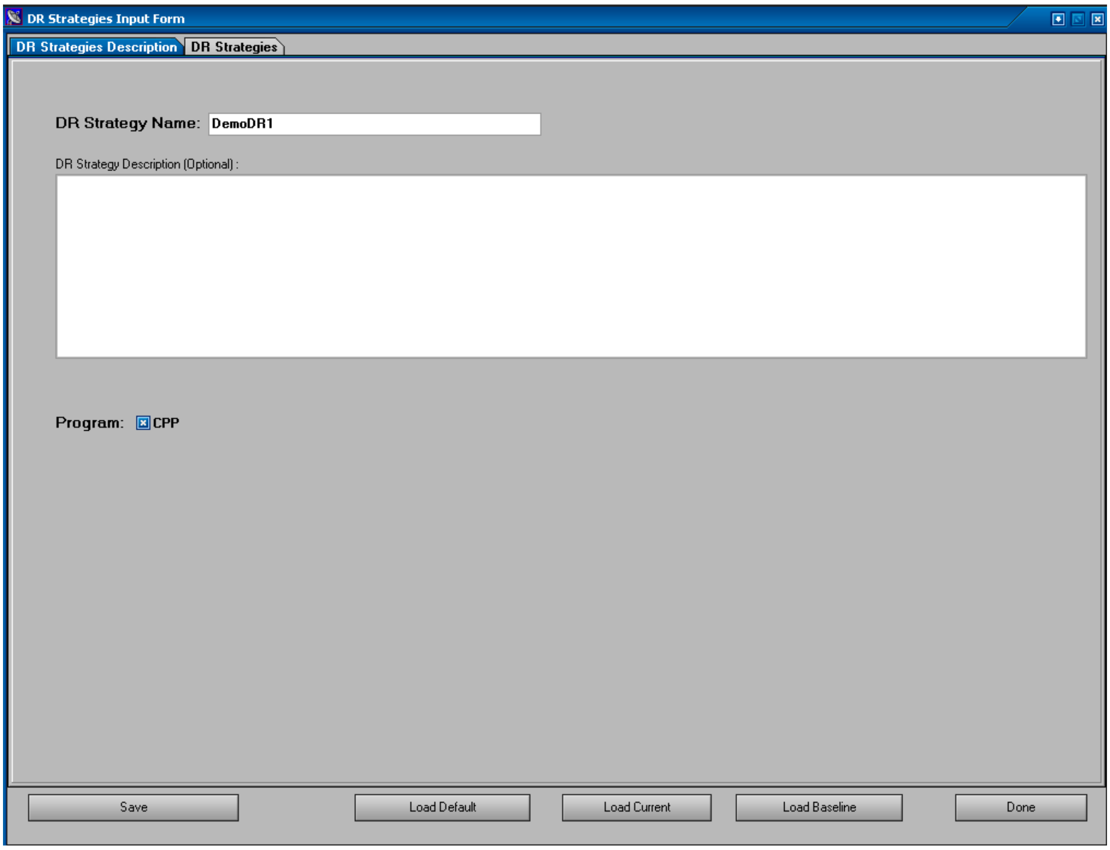


Figure 3-19 DR Strategies Input window

3.1.7.1 DR Strategies Description

Field: DR Strategy Name
Users must enter a name for the DR Strategy that will be specified in the DR Strategies tab.

Field: DR Strategy Description
The description of DR Strategy or other comments can be entered in this optional field.

Field: Program; Button: CPP
Clicking the CPP button in the Program field instructs DRQAT to apply the DR Strategies on all CPP days during the simulation period.

Once users select the "CPP" button, DRQAT would apply the DR strategy into the baseline model on CPP days. If not, the DR strategy would be in effort on everyday during simulation period.

3.1.7.2 DR Strategies

Clicking the "DR Strategies" tab displays the following DR Strategies schedule sub-tabs: HVAC Equipment Schedule, Zone Temperature Set-Point, Chilled/Condenser Water Set-Point, Supply Air Set-Point, and People/Light/Equipment Schedule. The DR Strategies schedules look and function just like the Baseline Schedules described in 3.1.5.2. Please refer to that section for descriptions and instructions for each schedule window.

3.1.7.2.1 HVAC Equipment Schedule

The DR Strategies sub-tab "HVAC Equipment Schedule" is shown in Figure 3-20 and functions just as its counterpart in Baseline Schedules. A description of the tables and instructions on setting values is found in section 3.1.5.2.1. DR strategy settings are entered in the tables labeled "Fan Workdays and Holidays Schedules" and Chiller Workdays and Holidays Schedules". Tables labeled "Baseline" displays the baseline values.

Button: Save
Click the "Save" button to save the current settings for each schedule tab (not just the one in the display).

Button: Load Default
Click "Load Default" button to load default values for each schedule tab (not just the one in the display).

Button: Load Current
Click "Load Current" button to load the last value saved for each schedule tab (not just the one in the display).

Button: Load Baseline
Click "Load Baseline" button to load baseline value for each schedule tab (not just the one in the display).

Button: Done
Click "Done" to exit the DR Strategies Schedules window.

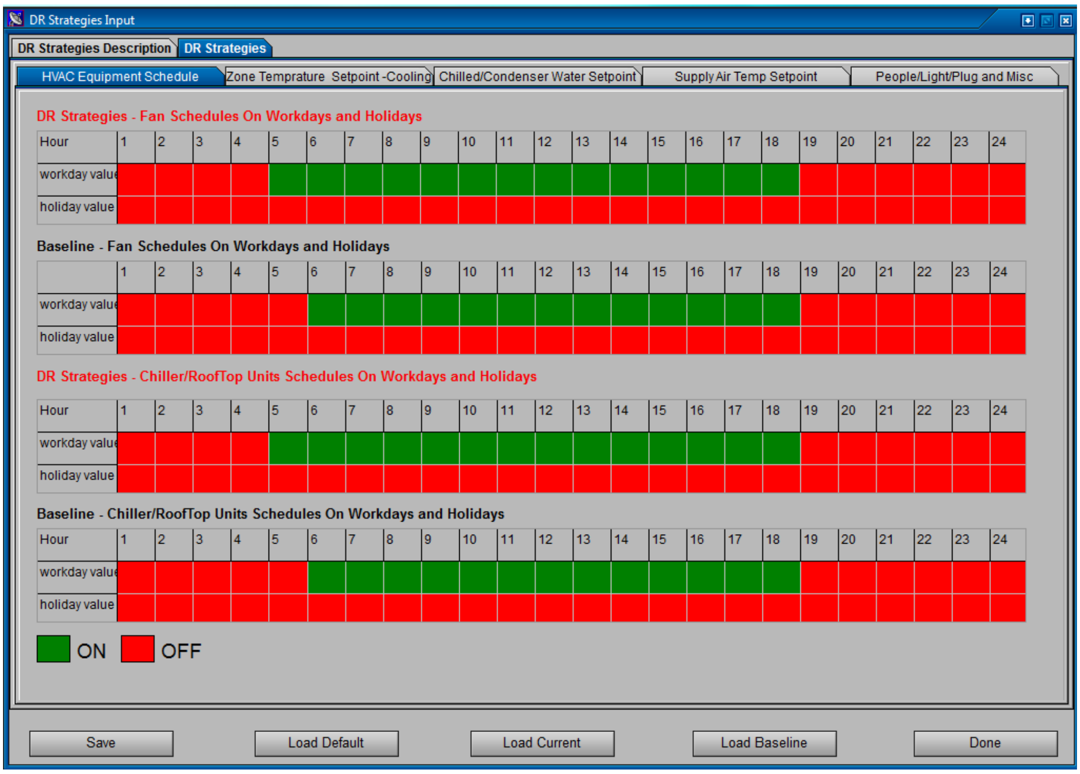


Figure 3-20 HVAC Equipment Schedule of the DR simulation model

3.1.7.2.2 Zone Temperature Set Point-Cooling

The DR Strategies sub-tab "Zone Temperature Set Point (Cooling)" is shown in Figure 3-21 and functions just as its counterpart in Baseline Schedules. A description of the graphical input figures, the set-point table and instructions on setting values is found in section 3.1.5.2.2. White circles in the graphical input figures represent the DR strategy schedule and green circles represent the baseline values.

Button: Save
Click the "Save" button to save the current settings for each schedule tab (not just the one in the display).

Button: Load Default
Click "Load Default" button to load default values for each schedule tab (not just the one in the display).

Button: Load Current
Click "Load Current" button to load the last value saved for each schedule tab (not just the one in the display).

Button: Load Baseline
Click "Load Baseline" button to load baseline value for each schedule tab (not just the one in the display).

Button: Done
Click "Done" to exit the DR Strategies Schedules window.

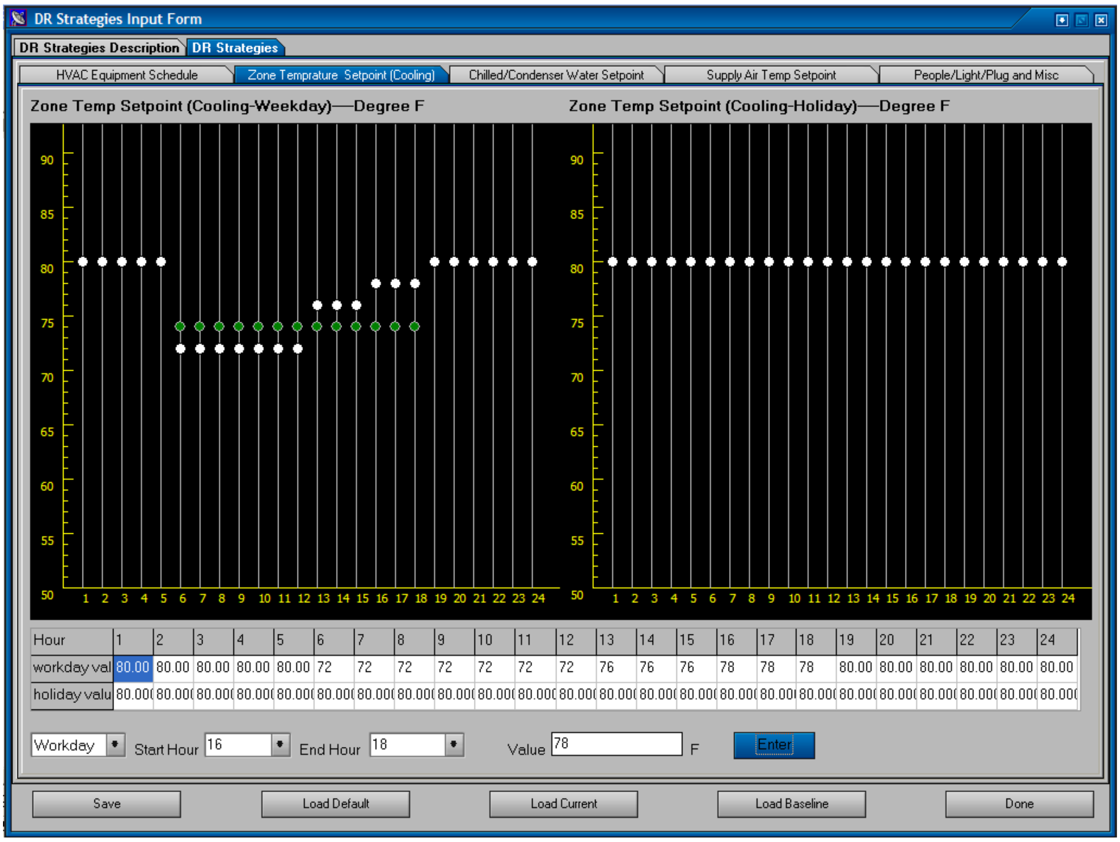


Figure 3-21 Zone Temperature Set Points of the DR Strategies

3.1.7.2.3 Chilled/Condenser Water Set point

The DR Strategies sub-tab "Chiller/Condenser Water Set-point" (not shown here) functions just as its counterpart in Baseline Schedules. A description of the graphical input figures, the set-point table and instructions on setting values is found in section 3.1.5.2.3. White circles in the graphical input figures represent the DR strategy schedule and green circles represent the baseline values.

Button: Save
Click the "Save" button to save the current settings for each schedule tab (not just the one in the display).

Button: Load Default
Click "Load Default" button to load default values for each schedule tab (not just the one in the display).

Button: Load Current
Click "Load Current" button to load the last value saved for each schedule tab (not just the one in the display).

Button: Load Baseline
Click "Load Baseline" button to load baseline value for each schedule tab (not just the one in the display).

Button: Done
Click "Done" to exit the DR Strategies Schedules window.

3.1.7.2.4 Supply Air Temp Set-point

The DR Strategies sub-tab "Supply Air Temp Set point" (not shown here) functions just as its counterpart in Baseline Schedules. A description of the graphical input figure, the set-point table and instructions on setting values is found in section 3.1.5.2.4. White circles in the graphical input figures represent the DR strategy schedule and green circles represent the baseline values.

Button: Save
Click the "Save" button to save the current settings for each schedule tab (not just the one in the display).

Button: Load Default
Click "Load Default" button to load default values for each schedule tab (not just the one in the display).

Button: Load Current
Click "Load Current" button to load the last value saved for each schedule tab (not just the one in the display).

Button: Load Baseline
Click "Load Baseline" button to load baseline value for each schedule tab (not just the one in the display).

Button: Done
Click "Done" to exit the DR Strategies Schedules window.

3.1.7.2.5 People/Light/Equipment Schedule

The DR Strategies sub-tab "People/Light/Equipment Schedule" (not shown here) functions just as its counterpart in Baseline Schedules. A description of the graphical input figures and instructions on setting values is found in section 3.1.5.2.5. Yellow bars with numerical labels (percent values) in the graphical input figures represent the DR strategy schedule and white lines represent the baseline values.

Button: Save
Click the “Save” button to save the current settings for each schedule tab (not just the one in the display).

Button: Load Default
Click “Load Default” button to load default values for each schedule tab (not just the one in the display).

Button: Load Current
Click “Load Current” button to load the last value saved for each schedule tab (not just the one in the display).

Button: Load Baseline
Click “Load Baseline” button to load baseline value for each schedule tab (not just the one in the display).

Button: Done
Click “Done” to exit the DR Strategies Schedules window.

3.1.8 Run DR Simulation

Click the “Run DR Simulation” button on the main window to open the “Run Control Form” shown in Figure 3-18. The DR Simulation can only be run after a Baseline Simulation has been successfully run.

Button: Run
Clicking the “Run” button starts the run. If the “Show details” button is checked a DOS window will display the DRQAT command and instruction activity. The run can take several minutes. An “OK” pop-up will open at the completion of a successful run. If a run fails to run successfully errors will be listed in the “Error Report” text box.

Button: Terminate
Clicking the “Terminate” button stops the run.

Button: Done
Clicking the “Done” button closes the window. If a run has been successfully completed the “Report” indicator in the main window will have turned from black to green.

3.1.9 Report

After completing a successful Baseline simulation (or successful Baseline and DR simulations), the "Report" button in the main window will change color form black to green. Clicking the "Report" button will display the reports window. The window contains four tabs that each contains a different simulation result summary. Each of the result summary tabs is described below.

3.1.9.1 Average Zone Temperature and Comfort

The "Average Zone Temperature and Comfort" report window is shown in Figure 3-22. A display of the two parameters can be made for the entire simulation period or any period (minimum 1 hr) within the simulation period. The display period is selected by entering the "Start Date" with the month and day pull-downs, entering the "Start Time" in the hour and minute pull-downs, entering the duration in the "Lasting Hours" text box, and clicking the "Show" button. Clicking "Print" will send the plots currently displayed to the printer. The "Average Zone Temp" plot displays the average of all of the model zone temperatures of the building. The "Average Zone Comfort" can be displayed in either PPD or PMV by selecting the corresponding button above the "Average Zone Comfort" plot.

PMV represents the "predicted mean vote" (on the thermal sensation scale) of a large population of people exposed to a certain environment. PMV is derived from the physics of heat transfer combined with an empirical fit to sensation. PPD is the predicted percent of the dissatisfied people at each PMV. As PMV changes away from zero in either the positive or negative direction, PPD increases.

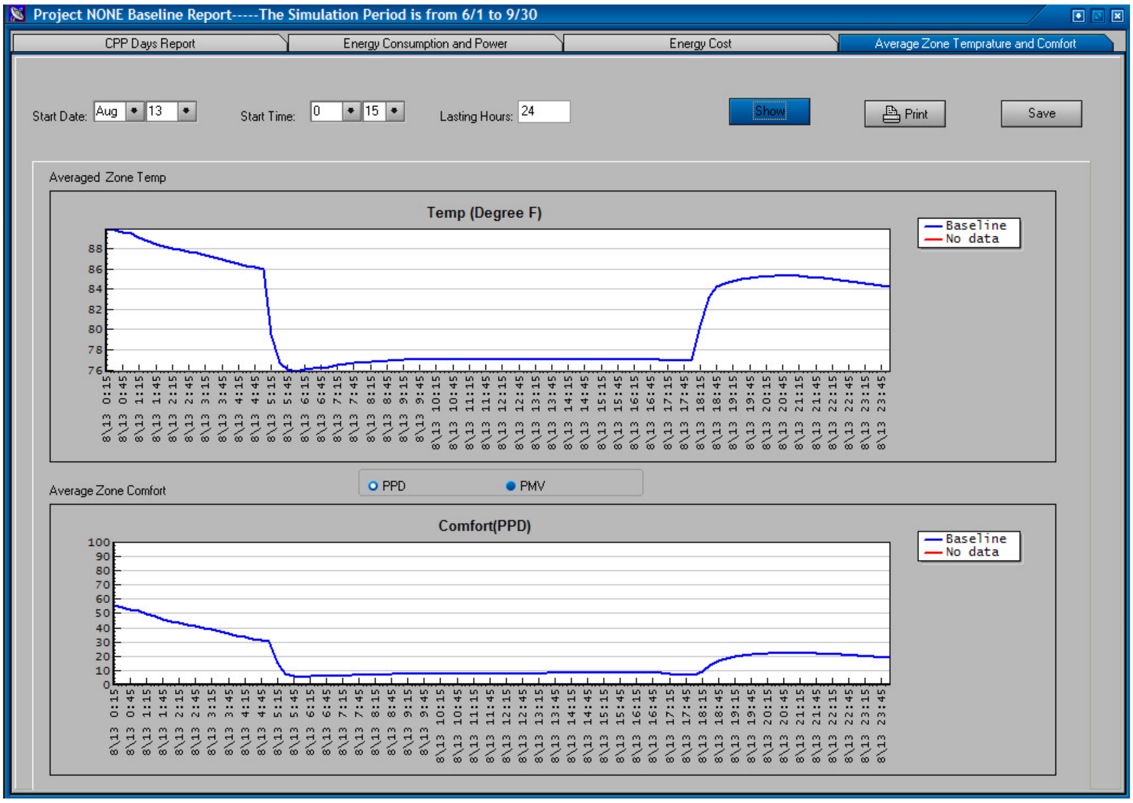


Figure 3-22 Report of the simulation results

3.1.9.2 Energy Consumption and Power

Clicking the "Energy Consumption and Power" tab will display the window shown in Figure 3-23. Energy consumption can be displayed 15-min time steps by selecting the "Step " tab or in hourly, daily, monthly, or seasonal averages by selecting the respective tab. The "Step" display window is shown in Figure 3-21. Energy consumption can be displayed for any period within the simulation period by entering the "Start Date" in the month and day pull-downs, entering the "Start Time" in the hour and minute pull-downs, entering the duration in the "Lasting Hours" text box, selecting a sub-system (Chiller, Fan, Equipment, HVAC, Lights) or Total (for whole building consumption) with the blue buttons, and clicking the "Show" button. Clicking "Print" will send the plots currently displayed to the printer. The sub-systems are self-explanatory with the possible exception of "Equipment" which refers to plug loads.

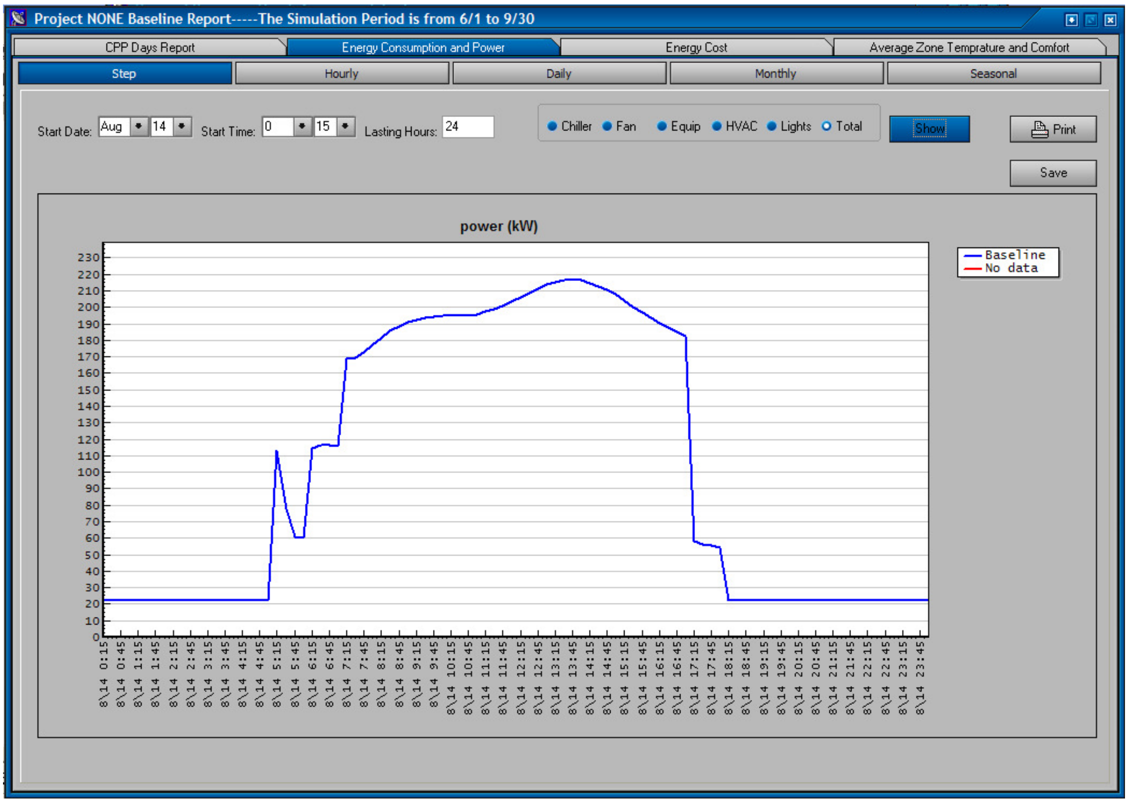


Figure 3-23 Energy Consumption and Power-Step

Clicking the "Hourly" tab displays the window shown in Figure 3-24. This window contains two sub-tabs, "Time Series" and "Bins and Pies". The "Time Series" window is shown in Figure 3-22 and has a plot for Baseline Power consumption above a plot for power consumption using the DR strategy. . Energy consumption can be displayed for any period within the simulation period by entering the "Start Date" in the month and day pull-downs, entering the "Start Hour" in the hour pull-down, entering the duration in the "Lasting Hours" text box, and clicking the "Show" button. Clicking "Print" will send the plots currently displayed to the printer. Selecting the "Report Difference" check box will the sub-systems are self-explanatory with the possible exception of "Equipment" which refers to plug loads.

Figure 3-24 Energy Consumption and Power-Hourly, Time Series

Clicking the "Bins and Pies" tab displays the window shown in Figure 3-25. To display energy consumption over a 1 hour period select the "Date" with the month and day pull-downs, select the "Specific Hour" with the hour pull-down, and click the "Show" button. Power in units of kW for each sub-system (chiller, fan, light, equipment, and HVAC) are displayed for both the Baseline and DR Strategy simulations in the upper bar chart. The percentage of whole building power for each sub-system is shown in separate pie charts for the Baseline and DR Strategy simulations.

Clicking "Print" will send the plots currently displayed to the printer.

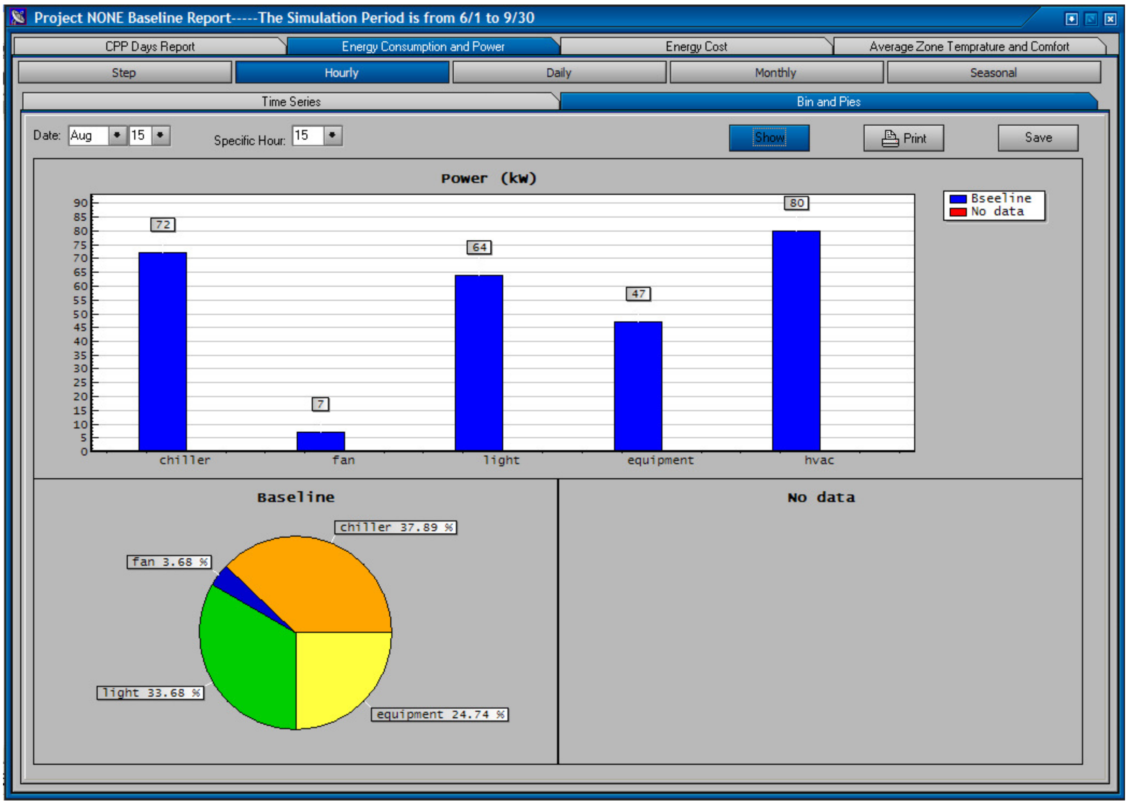


Figure 3-25 Energy Consumption and Power-Hourly, Bins and Pies

The “Daily” tab in the “Energy Consumption and Power” tab functions nearly identically to the “Hourly” tab except that only month and day are specified. Please refer to description of “Hourly” tab for instructions.

The “Monthly” tab in the “Energy Consumption and Power” tab will display the window shown in Figure 3-26. There are two sub-tabs for displaying “All Simulated Months” or a “Specific Month”. Clicking “Show” In the “All Simulated Months” tab (shown in Figure 3-26) will display the energy consumption for each sub-system as well as the total for each month in the simulation period. The upper plot shows the Baseline results and the lower plot shows the DR Strategy results. Checking the “Report Difference” check box and clicking “Show” will display the difference between the Baseline and the DR Strategy energy consumption for each month in the simulation period in the lower plot.

The “Specific Month” tab within the “Monthly” tab is shown in Figure 3-27. Monthly energy consumption data for the Baseline and DR Strategy simulations can be displayed in the upper bar chart for any month in the simulation period by selecting the month in the pull-down on the left and clicking “Show”. The percentage of energy consumption of each of the sub-systems for the Baseline and DR Strategy simulations are shown in pie charts below the bar chart.

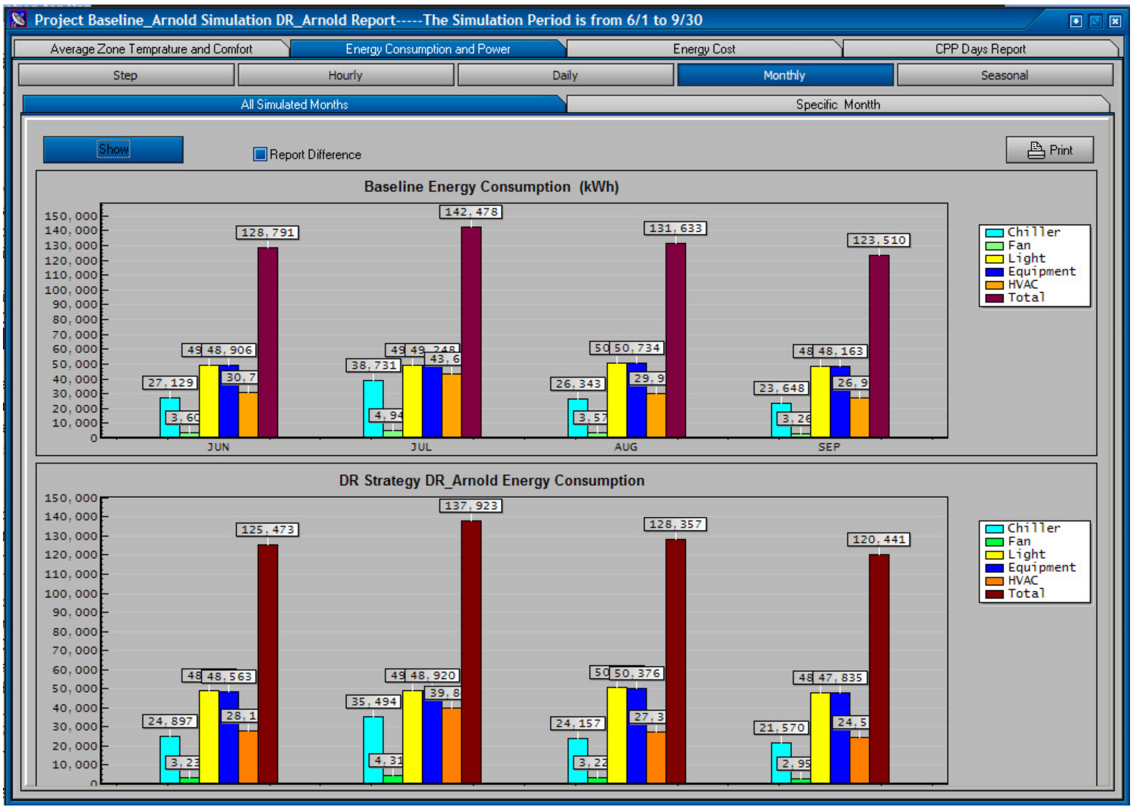


Figure 3-26 Energy Consumption and Power-All simulated months

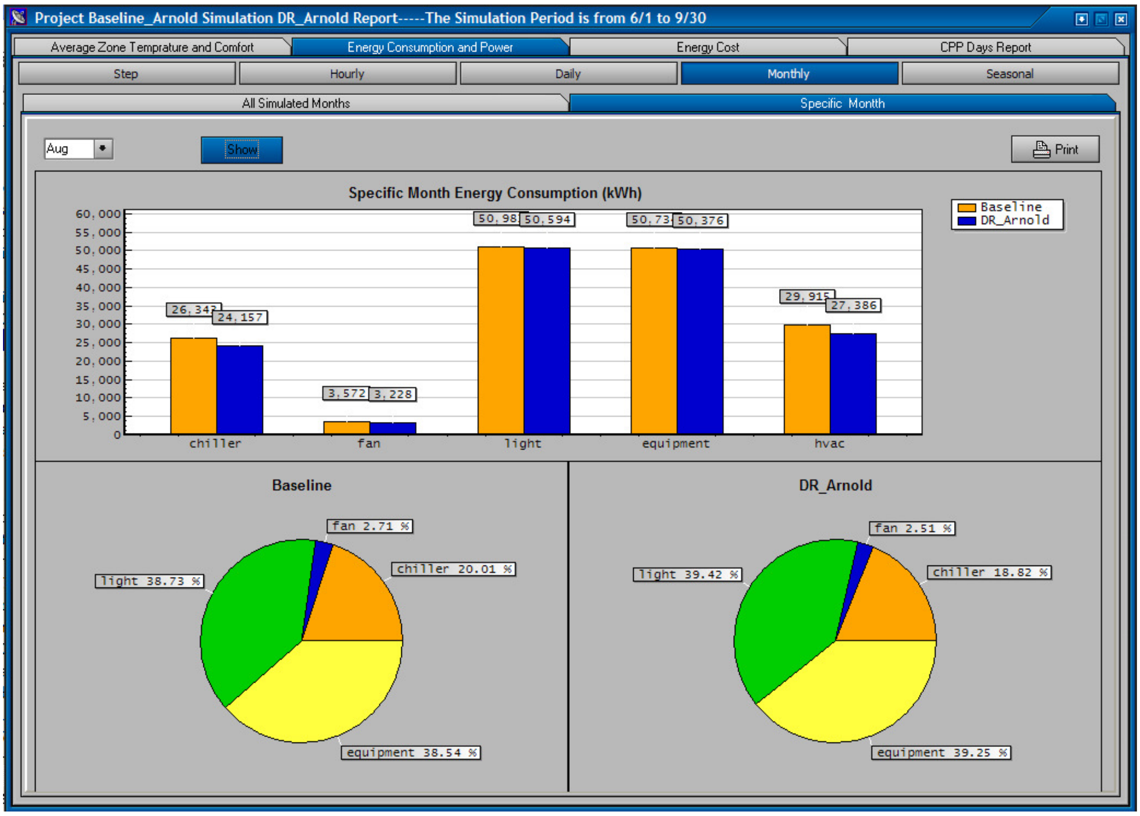


Figure 3-27 Energy Consumption and Power-Special month

The "Seasonal" sub-tab of the "Energy Consumption and Power" tab displays energy consumption data by season and functions identically to the "Monthly" display. Please refer to the "Monthly" tab description above for instructions.

3.1.9.3 Energy Cost

Energy cost figures can be displayed by clicking the "Energy Cost" tab in the top level of the reports window as shown in Figure 3-28. Energy costs can be displayed monthly or seasonally in the same way that energy consumption is displayed in the "Energy Consumption and Power" tab. Please refer to section 3.1.9.2 for instructions.

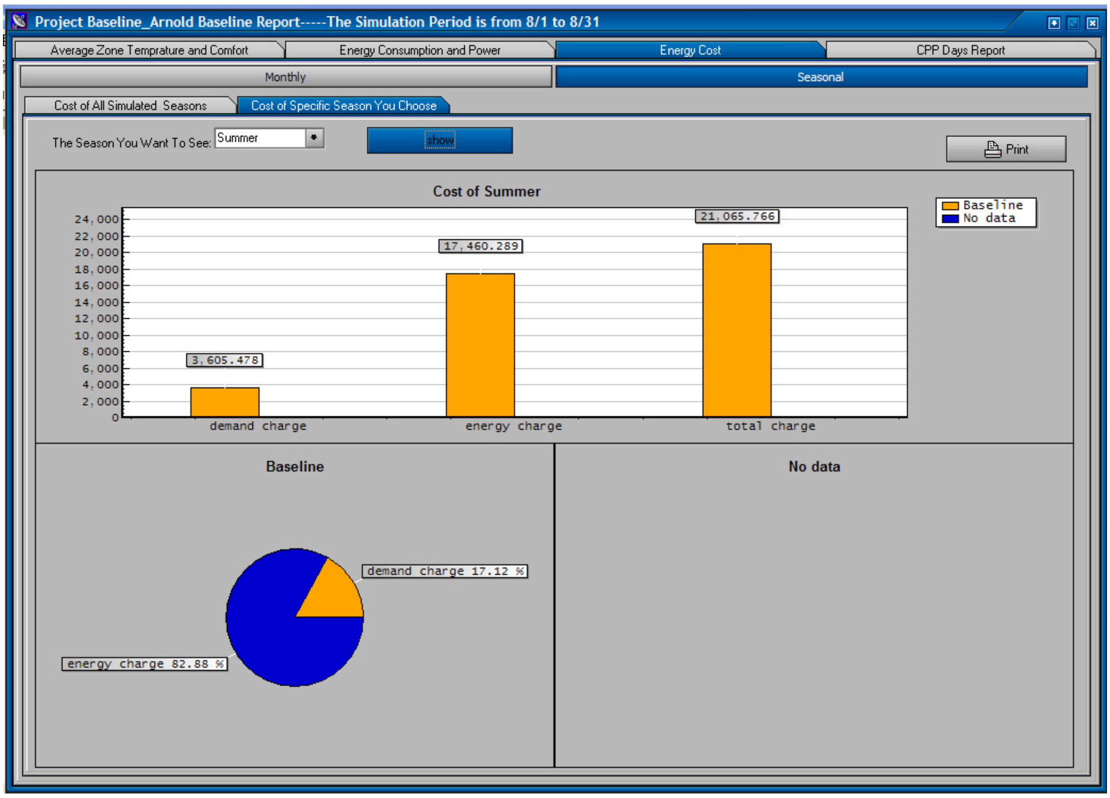


Figure 3-28 Energy Cost

3.1.9.4 CPP Days Report

The "CPP Days Report" tab in the reports window is shown in Figure 3-29. The upper table on the left of the window lists all CPP days in the calendar year and the table in the lower left lists all CPP days in the simulation period. The two right-hand columns in each table list the peak outdoor temperature and the corresponding hour. Clicking on a row in the lower table will display the average zone temperature in the upper plot and the whole building power consumption in the lower plot for both the Baseline and DR Strategy simulations of that particular CPP day. Clicking "Print" will send the plots currently displayed to the printer. Clicking "Save" will open a

"Save As" dialog box for saving the plots to a file as bitmaps.

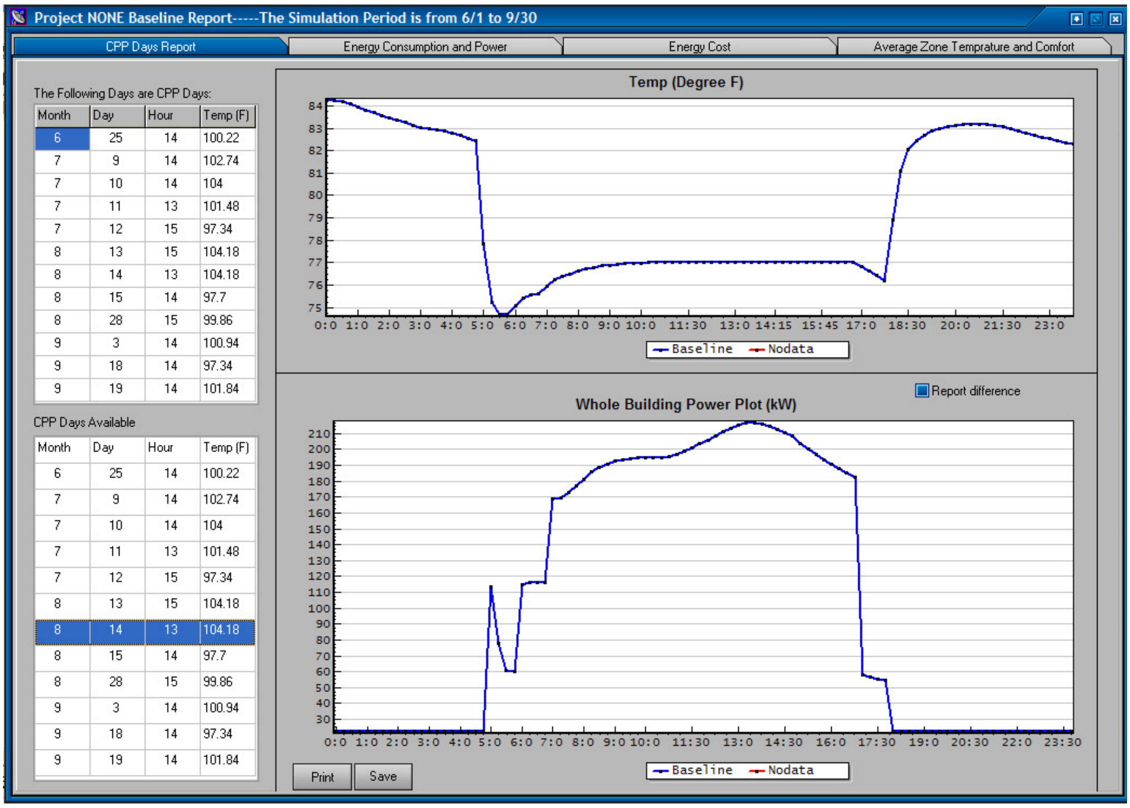


Figure 3-29 CPP Days Report

Figure 3-30 CPP Days Report-Comparison between the baseline model and DR model

The left-top table on the page shows all CPP days. The left-bottom table shows all CPP days during simulation period. Click the second table to see zone temperature and whole building power of that CPP day. As shown in Figure 3-30, the curves in blue and red represent the whole building power of baseline model, and DR model respectively. By clicking “Report difference”, it shows the power difference between the baseline model and DR model.

4 References

2005 Building Energy Efficiency Standards for Residential and Non Residential Buildings, California Energy Commission, 2005.

Input/Output Reference, EnergyPlus Manual, Version 4.0.0, October 2009.